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FORWARD...FROM THE SEA INTO THE TORPEDO DANGER ZONE

Blue Water ASW Doctrine in Shallow Water

A Monograph
by

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School of Advanced Military Studies
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Abstract

This paper examines the threat modern diesel submarines pose to successful joint power projection from the sea. America's force projection strategy requires littoral battlespace dominance by naval forces to give joint commanders the freedom of action afforded by a secure sea flank. The focus on operations ashore and cruise missile proliferation, magnified by the outcome of the Falkland's war, has overshadowed the submarine's more lethal sea denial weapon--the torpedo. The disadvantage that cut backs in force structure and a joint doctrine of "quick decisive victory" place on power projection efforts is exacerbated by current ASW equipment's limited effectiveness in shallow water. The offensive ASW doctrine based on the demands of maritime strategy will only work in shallow water if American ASW forces possess the same detection and attack asymmetry they enjoyed during the cold war. Current doctrine demands "zero defects ASW" with equipment which does not provide littoral battlespace dominance. When conditions ashore do not permit the joint commander the luxury of waiting for ASW forces to find and destroy submarines, the commander can easily lose critical power projection assets he needs to build combat power ahore by rushing into the torpedo danger zone.

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CHAPTER I: INTRODUCTION

"The whole power of the United States...depends upon the power to move ships across the sea. Their mighty power is restricted: it is restricted by those very oceans which have protected them. The oceans which were their shield, have now become a bar, a prison house, through which they are struggling to bring armies, fleets and air forces to bear upon the great common problems we have to face." -Winston Churchill, 1943-[1]

The ASW Imperatives of Power Projection

Antisubmarine Warfare(ASW) was the United States Navy's top priority mission in executing the Maritime Strategy of the 1980's.[2] This emphasis was based on two strategic requirements: defeating the Soviet nuclear attack submarine(SSN) fleet in order to safely project military forces across the sea lines of communication (SLOC's) to defend Western Europe; and neutralizing the Soviet nuclear ballistic missile submarine(SSBN) fleet.[3]

To defeat the submarine threat and fulfill its strategic mission, the United States Navy made an enormous investment in ASW hardware. Ironically, the equipment developed for optimizing passive acoustic detection is not optimized for detecting the post cold war submarine threat--conventional and Air Independent Propulsion(AIP) modified diesel-electric submarines operating in coastal waters. Modern diesel-electric submarines are virtually undetectable by current passive acoustic sensors when operating on battery power.[4]

". . .From the Sea," published by the Navy in 1992, adopts power projection ashore as the Navy's main function in America's post-cold war force projection strategy.[5] Senior officials publicly stated that ASW was no longer the Navy's

number one mission.[6] A follow on paper published in 1994, "Forward...from the Sea," reconfirms this position.[7] These documents, and the capstone naval doctrinal manual, Naval Doctrine Publication One (NDP-1), focus naval doctrinal thinking on littoral warfare. This is consistent with the National Security Strategy, which no longer asserts freedom of the seas as a necessary American strategic concern-- it assumes control of the sea as a given.[8]

The theoretical basis for this assumption is unclear; it rejects Captain Alfred Thayer Mahan's and Sir Julian Corbett's theories that control of the sea is in doubt until one side achieves it, locally or generally, in time of conflict.[9] The Navy's assertion that it is a self-sustaining force is only valid when it has command of the sea in a given locale. The oilers and logistics vessels that supply naval expeditionary forces create a logistic tail stretching back to America. Disruption of these SLOC's does not require an opponent to have command of the sea; it only requires him to dispute command of the sea long enough to interdict the SLOC's.[10]

Two traditional naval missions foreseen in the future are force projection and presence.[11] They provide the National Command Authority(NCA) with both violent and non-violent modes of military action using essentially the same assets. Both missions require littoral battlespace dominance-- projecting "zones of superiority" on, above, and below the sea, as well as ashore.[12] Logistic support for joint force projection requires secure SLOC's. A recognized vulnerability in current strategic thinking is the diesel submarine's effectiveness in sea denial. Of 43 nations operating diesel submarines, 35 are upgrading their submarine fleets.

The Navy must not, in projecting power ashore, neglect a necessary precondition for successful littoral operations--freedom of action at sea.[13]

Freedom of action for a joint force operating in the littoral is the necessary precondition for success. No land force commander dependent upon SLOC's can afford to experience frequent destruction of his supplies.[14] The loss of sea borne strike assets, or their continual diversion for self defense, reduces his combat power. With the majority of strategic lift coming by sea, the joint force commander cannot assume risk in his operational rear-- his operation will grind to a halt.[15] Naval forces must destroy and/or defeat opposing submarines for the joint force to succeed.

How Submarines Seny Littoral Access and Freedom of Action

Submarines can achieve sea denial by sinking vessels, by attacking and causing them to flee, or by creating unacceptable risk of surprise torpedo attack in a commander's mind. Submarines can also mine sea avenues of approach to littoral areas, for either offensive or defensive purposes. A submarine can act as a "floating mine" by loitering in a choke point, or other defensive zone, and attacking any suitable target that passes within range. Submarines are stealthy platforms that exploit the stealth-given advantage of surprise.

Submarines deny freedom of action to expeditionary forces by putting combatant vessels at risk in desired areas of operation, and by interdicting sea LOC's through attacks on commerce and supply vessels. While offensive interdiction is the riskier mission for the submarine, the payoff for sinking oilers,

military resupply ships, or troop transports is high-- disrupting or prematurely culminating a littoral operation. Sinking combatants and amphibious assault ships dilutes the joint force commander's ability to project power ashore; sinking an aircraft carrier may jeopardize air superiority. Sinking any American ship may also pay big dividends in the forum of world opinion.

Doctrinal Issues

Blue water ASW doctrine focusses on sinking the submarine before it fires its weapons. In the context of a naval force at sea, the high value unit, be it a carrier, an amphibious flotilla, an oiler, or even a battleship, is surrounded by expanding zones of defense. (See Figure 1.) The farthest out zone is the enemy's home port. Next are the surveillance/early warning zone, the outer zone, the inner zone and, lastly, the torpedo danger zone-- an area around a ship where a torpedo attack is likely to hit, and either disable or sink, the unit. While evading the submarine is sometimes effective, the speed and endurance of nuclear attack submarines and the presence of multiple submarines in an AO render evasion a temporary solution.

The shallow water ASW problem for a power projecting expeditionary force constrains seaborne operations. There is a finite area in which the force must operate in order to effect events on land. Unlike open ocean scenarios, ships in shallow water are frequently restricted in their options for evasive maneuver-- though their speed advantage, 30 knots for surface combatants over 12 to 20 knots for submerged diesel submarines, can be temporarily exploited. Modern diesel

submarines have sufficient fuel endurance to reacquire enemy ships operating in their defensive zones. ASW forces must sink submarines and/or neutralize any weapon they launch.

ASW architecture is built upon combined arms search and detection by passive acoustic, active acoustic, radar, electronic, visual, and infrared sensors. The technical and tactical challenge is to find the submarine before it gets to the inner zone. Once found, the submarine can be attacked and either destroyed, or forced to evade and abort its mission.

Even with modern hardware, classifying an underwater contact as a submarine is extremely difficult.[16] The frequency of false contacts and the short (relative to the area to be searched) detection ranges of acoustic equipment virtually guarantees that some submarines will close with the battle force. To prevent these submarines from sinking high value vessels, ships require counters to a submarine's weapons after they are launched. Some ships have quieting systems and acoustic decoys, capable of defeating acoustic homing torpedoes. However, there is currently nothing that can jam a conventional torpedo, and the new wake homing torpedoes await an effective counter[17].

The need to match ASW doctrine and equipment to counter the torpedo is the focus of this paper. Given current defense budgets, America cannot afford to buy and man extra ships to allow for attrition. The U.S. must make our ships, and hence its forward projected joint expeditionary forces, less vulnerable to defending diesel submarines. This monograph addresses the question, "Are current Navy

equipment and doctrine matched sufficiently to neutralize the shallow water threat of diesel-electric submarines during force projection scenarios?"

In answering the question, the paper uses lessons from experience with submarines in shallow water to refine the shallow water ASW problem. The environment and how submarines and ASW forces define success are shown to clarify vulnerabilities and capabilities. Naval doctrine's pursuit of littoral battlespace dominance is measured against predicted threat and equipment, using British theorist J.F.C. Fuller's "Maxim for the Ignorant: Guard, Move, Hit," with a fourth element,"Detect," added to provide contemporary focus: Detect, Guard, Move, Hit.[18] The model is used to assess ASW forces' ability to detect, avoid(Guard and Move), and attack(Hit) submarines, the interaction between these functions, and how these inhibit or enhance freedom of action(Move) in the littoral.

Simplified View of Blue Water ASW "Zones"

Range circles denote distance from CVBG to Enemy Submarine (not to scale)
Figure in center represents CVBG or other friendly High Value Unit.

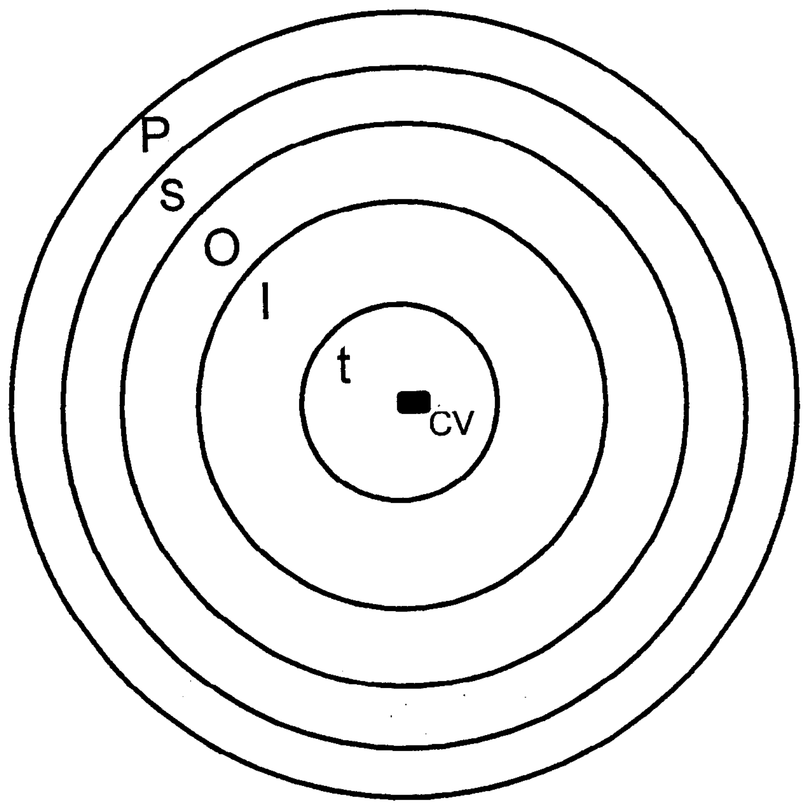


Figure 1

P= Enemy Submarine's home port. Distances in 100's to 1000's of nm.
S= Surveillance/ Early warning zone. Distances in 100's to 1000's of nm.
Zones **P** and **S** overlap. Use operational and strategic level sensors, including SSN's, IUSS, and Maritime Patrol Aircraft (P-3C), to detect and attack.
O= Outer zone; distances in 10's to 100's of nm. (Overlaps with zone **S** and **I**.)
I= Inner Zone. Distances in 10's of nm. (Overlaps with zones **O** and **t**.)
Escorts and their helicopters, carrier based aircraft(S-3B) and helicopters, and P-3's and SSN's in direct support of BG, all used to detect and attack. The idea is to kill the sub in **O** or **I** so he never gets to **Zone t**.
t= Torpedo Danger Zone. Distances in 1000's of yds to 10's of nm from CVBG. Use all sensors of zones **O** and **I**, as well as lookouts and ship launched torpedos.

CHAPTER II: SUBMARINES IN SHALLOW WATER

A submarine in the water scares the hell out of people.
ADM Kinnard McKee, USN[19]

Submarines defending a coastal area can have an effect all out of proportion to their number. This paper uses two illustrations of a submarine's disruptive effect. The first example, the raid on Wotje Island, part of Admiral William Halsey's Marshall Islands Raids of February 1942, shows the submarine's powerful impact in the moral domain. The second example, the Falklands/ Malvinas Campaign of 1982, shows how submarines add to the uncertainty and risk facing modern littoral commanders.[20] Modern warships must perform multiple missions simultaneously. They cannot focus exclusively on ASW--surface and air threats must be dealt with concurrently in order to dominate littoral battlespace.[21]

The Wotje Island Raid

Halsey's carrier raids on the Marshall Islands in February of 1942 included a combined carrier air and naval gunfire bombardment against the harbor on Wotje Island. While a minor event in some histories of the war, its outcome was frustrating to Rear Admiral Raymond Spruance. His naval gunfire bombardment mission was significantly hampered by submarines' psychological effects.[22]

After a sunrise air attack from *Enterprise* initiated the raid, Spruance led his ships, *Northhampton, Dunlap* and *Salt Lake City*, to within gun range of the atoll. After 13 minutes of bombardment,

> *Northhampton* reported a periscope on the port beam. Spruance didn't want to believe it He had considered the possibility of submarines at

> Wotje, decided there would be none, and had dismissed the submarine threat from his mind. He reluctantly ordered a cease fire and reversed course in an emergency turn...[the] radical change of course and speed disrupted the [gunfire] control solution.[23]

Spruance's raiding force lost mission focus. After other ships and aircraft reported periscope sightings, the shore bombardment mission was totally disrupted:

> Almost everyone except Spruance was convinced that submarines had surrounded the American ships. The cruisers twisted and turned to avoid torpedoes that their captains believed were streaking toward them. Spruance signaled his cruisers to disregard the "periscope" sightings, to no avail. Tactical discipline had broken, the guns could no longer fire, and Spruance watched helplessly as his panicked cruisers fled from imaginary submarines.[24]

Two aspects of moral influence emerge from this disrupted littoral operation. The first is the mindset of the commander. Whether he is right or wrong, the commander can so focus a mission ashore that ASW is virtually ignored. Spruance's instructions to disregard periscope sightings struck his subordinates as totally at odds with what they considered ample evidence of hostile submarines-- visual sighting of a periscope. Even today, visual sighting remains the best evidence of a submarine's presence-- short of torpedo impact or missiles rising out of the sea. Had the cruiser captains been less certain of a submarine's presence, they would likely have continued the shore bombardment. Spruance's belief that there were no submarines was an obstacle to preplanning an ASW effort involving spotter planes and the destroyer *Dunlap.* As a result, he lost freedom of action to the threat of submarine based torpedo attack during the raid.[25]

The second moral aspect is more basic. Ship captains fear being hit by

torpedoes. The sailors' adage,

> It is easier to sink a ship by letting water in from the bottom than it is by letting air out from the top,

should not be lightly dismissed.[26] Spruance's captains reacted to the threat of torpedo attack (real or imagined) by vigorous evasive maneuvers and abandonment of their mission.

Fleeing an "invisible" enemy possessing the means to sink a warship was tactically sound in the early days of World War II. The British aircraft carrier *Courageous* was sunk in the Irish Sea by three torpedoes from a German U-boat on September 17 1939.[27] Japanese torpedoes sank two battleships at Pearl Harbor.[28] At the Battle of Midway, the *USS Yorktown* was damaged by bombs, but was not abandoned to sink until it was hit by a submarine launched torpedo.[29] The carrier *Wasp* was sunk by three torpedoes from I-19 while escorting transports carrying elements of the 7th Marine Regiment.[30] The American Navy lacked sensors, weapons, and protective measures to counter both submarines and torpedoes until later in the war.[31]

Great advances in acoustic and electromagnetic submarine detection were made during the war. This progress continued into the cold war. Submarines also evolved, however, acquiring better battery technology, better weapons, and, in some navies, nuclear propulsion.[32] The ASW problem remained difficult, as the Argentine and British navies discovered in the 1982 Falkland Islands dispute.

The Falklands/Malvinas Campaign

The Falklands/Malvinas campaign was a joint power projection operation by both sides. The Falkland Islands lie 400 miles east of Argentina on the South American continental shelf. British rule was disputed by Argentina for over 150 years. On April 2 1982, the Argentine military landed on East Falkland Island and took control of the islands. Great Britain responded with a naval expedition that traveled over 6000 miles, achieved local sea control, and conducted amphibious operations which culminated in recapturing the Falkland Islands on June 14, 1982.[33]

The Argentines lost local sea control due to shortcomings in hardware. Their plan to defeat the British fleet, a combined strike by carrier aircraft, surface ships, and submarines, was sound. Their shortcomings in ASW hardware left them vulnerable to British submarines. This vulnerability had profound physical and moral effects on the Argentine Navy's operational performance.

The Royal Navy's successful power projection operation also suffered from hardware shortages. Land and sea based maritime patrol aircraft, and airborne early warning aircraft, were unable to reach the AO.[34] They accepted considerable risk, counting on their perceived superior skill and the added advantage of operating SSN's. The British ASW effort against a single diesel submarine was a draw-- the submarine retired safely without sinking any British ships. The operations of British and Argentine attack submarines are useful references for understanding shallow water ASW.

The Argentine ASW Effort

The British submarine force in the Falklands consisted of three SSN's and one conventional diesel submarine.[35] The Argentine's discovered through the press that British SSN's had deployed to the Falklands.[36] They knew the SSN's were in theater, but never located them -- until *HMS Conqueror* sank the cruiser *Belgrano* by firing two Mk-8 conventional torpedoes from less than 2000 yards away.[37]

The counterattack made by two Argentine destroyers drove *Conqueror* away temporarily. Argentina's lack of effective coastal ASW defense, including integrated underwater surveillance systems and maritime patrol aircraft coverage, put the entire burden of primary submarine detection on their ships and helicopters.[38] The limitations of their ASW equipment precluded detection and defeat of the British SSN threat.[39]

The moral effect of losing the *Belgrano* to an "invisible" sub, whom the Argentines realized they could not counter, resulted in the tactical decision to recall their fleet to Argentine territorial waters. Failure to establish battlespace dominance precluded naval support for land and air defense of the Malvinas. The navy could only provide land based carrier aircraft and one diesel submarine, the *San Luis,* to contest the British invasion.

The *San Luis* faced over 10 frigates and destroyers, each equipped with a Lynx or Wessex helicopter, as well as 18 Sea Kings operating from the carriers *Hermes* and *Invincible*.[40] This lone diesel submarine caused the British flotilla

immense concern, conducted multiple torpedo attacks, and returned home from its 36 day patrol unharmed.[41] While the *San Luis* sank no British shipping, it proved an elusive quarry for the British escorts.

The British ASW Experience

Admiral Woodward, commander of the Falkland Islands expedition, was an experienced submariner. He had previously commanded the diesel submarine *Tireless* and the first British SSN, *HMS Valiant*. He had also served as the senior instructor of the "Perisher" course, the most rigorous segment of British submarine crew combat training and command qualification.[42] He was intimately familiar with the advantages and limitations any opposing submarine would have in trying to deny him the littoral battlespace dominance his mission demanded.

Facing simultaneous surface, subsurface, and air threats, Woodward assessed the threats most likely to prematurely culminate his operation as air, surface, and subsurface, in order. His battle formations were optimized for layered anti-aircraft and anti-ship missile defense, including the Exocet missiles carried by Argentine warships.[43] For the assault on East Falkland, he had the luxury of facing only one active diesel submarine.[44]

Admiral Woodward's experience as both submarine captain and flotilla commander provide a credible view of the confusion present in modern littoral ASW. His descriptions evoke Clausewitz's friction and uncertainty. The presence of two Argentine diesel submarines operating in the AO was felt on every ship. British nerves were tested early in the campaign. Departing Ascension Island, their

forward base in the Atlantic, British ships spent an hour chasing an underwater contact eventually classified as a whale. Woodward considered this a normal occurrence:

> This was by no means the last occasion that whales caused us to get over excited...The Argentines could have easily put a submarine in the Ascension area in a bold attempt to finish the war before it started.[45]

Once the British arrived in the vicinity of the Falklands, the ASW effort was focused on preventing a submarine from disrupting the Antiair Warfare(AAW) screen. Woodward's experience helped him understand the challenge of creating a combined AAW and ASW screen.

> Any picket is a sitting duck to a well handled submarine. Single ships are especially vulnerable. Groups of two or three working together are harder to deal with. All submarine commanders know this.[46]

The British ships northeast of the Falklands had little enemy contact in the early stages of the operation. The night after South Georgia Island was recaptured, the threat of diesel submarines manifested itself in Clausewitzian friction. The difficulty in rapidly classifying subsurface contacts sorely taxed their night defensive screens.

> *Yarmouth* got a sonar contact that seemed very submarine like to him...we had a probable submarine on the loose, in the middle of the group, in pitch black conditions, with no navigation lights...It was nothing short of a melee...All quite exciting for a while, but order eventually emerged out of the chaos.[47]

The problem of classifying passive sonar contacts was to plague the ASW effort throughout the hostilities. On 4 May, after the *Sheffield* had been hit by Exocet missiles, HMS *Yarmouth* discontinued its firefighting assistance to *Sheffield*

to investigate a sonar contact. Woodward's narrative illustrates a limitation of passive acoustics.

> *Yarmouth* thought they heard a torpedo in the water and broke off to try and find the submarine that had fired it.[It found nothing] Then it happened again. And again. All together they thought they detected nine torpedoes that afternoon. Sometime later we deduced that the propeller noises they kept hearing on the sonar had [been] from the outboard motor which was buzzing around *Sheffield,* helping to fight the blaze. *Yarmouth's* commander could not believe this at the time; probably still doesn't.[48]

Unlike the Argentine navy, the British response to the submarine threat was aggressive search and pursuit of the enemy--regardless of the confusion and uncertainty. They believed their sensors, weapons and countermeasures were a sufficient counter for diesel submarines.[49] Their confidence may have been misplaced.

The British ASW efforts against the *San Luis* and a variety of non-submarine, underwater contacts was disappointing.[50] For at least ten days, the *San Luis* tried to sink British warships. While maintaining an AAW screen for protection against air and missile attack, the British escorts expended a great deal of ordnance in attacking underwater contacts. "Virtually every anti-submarine weapon in the task force was expended on false submarine contacts."[51] The British were successful, in that no ships were lost to torpedoes, but this was not solely due to their ASW efforts.

On 1 May, the *San Luis,* using only sonar to calculate a firing solution, launched a torpedo from less than about 2000 yards range at a warship, but missed

due to a weapon malfunction. It withstood and evaded approximately 20 hours of sonar prosecution, and torpedo and depth charge attack, from three frigates and supporting helicopters. The British scored no hits--although pilots reported "an oil slick one-half a mile long." On 5 May, *San Luis* attacked another ship, but a weapons control panel malfunction frustrated the attack. Sea King helicopters attacked *San Luis* with depth bombs and torpedoes, scoring no hits. On 10 May, *San Luis* attacked two warships north of San Carlos Straights from a range of 5000 yards. One torpedo hit but failed to explode, and another malfunctioned due to wire guidance problems. No counterattack was made. *San Luis* settled on the bottom on numerous occasions during this period to reload empty torpedo tubes, repair an apparently capricious weapons control panel, and hide from the frigates and helicopters.[52]

The difficulty in accurately attacking a small, evasive diesel submarine embarrassed the British ASW forces. The reason for *San Luis's* survival can be attributed to a combination of factors, including weapons limitations, high false contact rates, erroneous attacks, and sonar degradation in shallow water. These, and the efforts of the crew to remain "invisible", added considerable friction to the problem of finding and destroying *San Luis*. Were it not for its own weapon systems malfunctions, *San Luis* would have damaged, and perhaps sunk, at least three British ships.

The Falklands/Malvinas Conflict as Seen by Critics

The "lessons learned" from the Falklands/Malvinas campaign cover every

facet of littoral operations. ASW conclusions from the outcome of the Falklands/ Malvinas Campaign include the continued utility of diesel submarines, the unsuitability of contemporary sensors for localizing and accurately attacking submarines in shallow water, and the continued lethality of the torpedo. Russian observers concluded that the Argentine submariners' deficiencies, in crew training and maintenance, illustrates that navies need to conduct "intensive training to ensure [such] problems were minimized during future operations."[53] Nations operating diesel submarines undoubtedly took note.

An aspect of ASW that has not changed since World War II is the numerical imbalance between submarines and the assets required to find and destroy them. During the Battle of the Atlantic, the counter to an offensive submarine campaign, the assets required to win amounted to 25 ships and 100 planes for every submarine.[54] The British experienced a similar imbalance in the Falklands against a defending submarine. It took the efforts of over 20 helicopters and 10 ships to eventually drive off *San Luis*.[55] The British warships were multi-mission platforms, simultaneously defending against aircraft bombs and missile threats while trying to defeat a submarine defending its territory.

Whether a submarine is in an offensive or defensive role determines its "indiscretion time:" the time it is exposed above the water's surface. A submarine on an offensive mission must travel faster and therefore must snorkel, surface transit, and recharge batteries more frequently than one defending an area. The *San Luis* was not required to expose itself as often as an offensive submarine. Low

indiscretion increases the rcliance on non-visual, non-radar, detection techniques.

The unsuitability of British sensors and weapons in defeating submarines in shallow water caused great concern among American ASW practitioners. While our sensors continue to improve, there is still no air launched weapon which has proven effective in shallow water.[56] America's force projection national strategy will likely operate in an environment similar to the Falklands campaign--diesel submarines defending in shallow water, trying to deny use of the littoral as a base for power projection ashore.

Why Diesel Submarines are the Threat

Some American and Russian analysts concluded that the Falkalnds conflict established the SSN as the dominant ship in modern naval warfare.[57] The British SSN's certainly outperformed the Argentine diesel submarines. The poor handling of *Sante Fe*--caught on the surface--and the failures of *San Luis*' weapon systems, rendered them both mission ineffective for littoral defense. Their failure, however, cannot outweigh *San Luis'* success in maneuvering into position to conduct attacks on multiple British ships. A victim of the "friction" of faulty weapons performance (a problem encountered for nearly two years by American submariners in WW II), she was as effective as the SSN *Conqueror* in stealthily targeting hostile surface targets.[58] The disparity in results should not blind naval critics to the similarity between the British SSNs' and the Argentine diesel submarines' defensive roles. If one views the British battle group's AO as defended territory, then the SSN's fulfilled a defensive role, exercising sea denial against the

Argentine Navy.

The SSNs' mission was to defend the British battle force.[59] The Argentine Navy's aircraft, and its ship and aircraft launched Exocet missiles, posed the major naval threat to the British forces operating. The SSN's mission essential task was to destroy Argentine naval units before enemy weapons could reach the British task force.[60] *Conqueror's* sinking of the *Belgrano* achieved sea denial by convincing the Argentine naval command that they could not operate in the AO at an acceptable risk level.[61] Admiral Woodward asserts that, if properly handled, Argentine diesel submarines would have achieved the same results against him.[62]

The British SSN's and the *San Luis* patrolled similar sized sectors. The SSNs' defensive zone was divided into four sectors, each covering roughly 20,000 square nm.[63] A modern diesel submarine with a range of 6-8,000 nm and an endurance of 45 days, such as a German Type 209 or a Russian Kilo, can patrol such an area for three to four weeks.[64] *San Luis* patrolled a similar area for 36 days, including transit time.[65] While fuel limitations set temporal limits to *San Luis'* mission, the British task force also faced time constraints.[66] The greater endurance and speed of the SSN's could not alleviate operational and strategic deadlines.[67]

On paper, SSN's outperform diesels--particularly at the operational level. The British SSNs' ability to quickly arrive in theater, then operate stealthily without resupply, was an important part of the British campaign design. The SSN's success could trigger attempts by non-nuclear navies to acquire SSN's. Since most nations

do not practice global power projection, proliferation is unlikely due to the combination of high costs and operational limitations.

SSN's are expensive. The $2 billion price tag on a *Seawolf*, or the $1.2 billion for the follow on *Centurion*, is extravagant for a navies operating in littoral regions. At $220 million, a Dutch *Walrus* or a German Type 1700 can fulfill defensive needs more economically. The infrastructure and training required to build and maintain SSN's demands a robust economy. Only the United States, Russia, Britain, France and China operate SSN's. India leased a Soviet nuclear attack submarine in 1988, but returned it to the Soviet Union after a four year trial.[68] Other nations, notably Argentina and Brazil, considered buying French SSN's, but have yet to procure them.[69] Few nations possess both the industrial base and financial means to produce, maintain, and man SSN's.[70] Even the United States has only one shipyard currently producing nuclear submarines.[71]

The operational limitations imposed on nuclear submarines in shallow water do not necessarily justify their cost. An SSN's speed advantage cannot be fully exploited in shallow water. Cavitation, a function of depth and speed, is a major source of detectable noise. High shipping densities and poor sonar conditions require more frequent periscope usage to maintain an accurate tactical plot. Finally, American submarines still retain an acoustic advantage over any other nuclear submarine. No nation would purchase an expensive weapon which fights at a disadvantage, when cheaper diesel submarines can often maintain acoustic advantage over SSN's in shallow water. Navies looking for stealthier,

more capable submarines can acquire near-SSN performance, without the cost of building and maintaining SSN's, by investing in AIP diesel submarines.

Air Independent Propulsion(AIP)

The Swedish *Gotland* class, the Russian *Beluga* class, and the German Type 212 are all equipped with AIP.[72] This modification gives diesel submarines greater submerged endurance. AIP diesel-electric submarines make submerged operation of an air-breathing diesel engine possible. This lets the submarine recharge its batteries without having to snorkel or surface. The AIP diesel submarine can act like a nuclear submarine, in that it need not surface, for a period of time up to five times longer than a non-AIP diesel[73]. While this capability will not duplicate an SSN's capacity for global power projection , it reduces a defending submarine's risk of counterdetection during its most vulnerable condition--recharging its batteries. AIP modification decreases a submarine's snorkel and surfaced operation up to 80 per cent. This reduces non-acoustic detection opportunities by at least 50 per cent.[74]

A further advantage AIP creates is the ability to sustain high submerged speeds. The AIP can sustain high submerged speeds more frequently, without surfacing or paying the SSN's noise penalty of running nuclear powered steam turbines. This produces a larger combat radius and better evasion performance.

AIP gives a defender an SSN's stealth, and near SSN speed and endurance, without paying SSN prices for initial cost, maintenance, training, and safety. Methods of retrofitting AIP into current diesel submarines are under development

in both Russian and European shipyards. Submarine defensive performance in the shallow waters around the Falklands, and diesel submarine proliferation in small and medium sized navies, confirms that future joint expeditionary forces can expect to be confronted by submarine launched torpedo attack. Torpedoes, however, are not the only littoral threat to American forces.

Cruise Missiles: The Star of the Falkland's War.

A revelation of the Falkland's war was the lethality and effectiveness of Exocet missiles, which sank three British ships. Pictures of the *HMS Sheffield* burning became a symbol of the Falkland's War. These missiles were launched from aircraft-- the littoral threat now includes submarine launched cruise missiles. American and Russian submarines are equipped with cruise missiles, and many navies are buying either American Harpoon or French Exocet missiles, modified for launch from 53 cm torpedo tubes.[75] Efforts to counter Antiship Cruise Missiles(ASCM's) can be traced to the 1967 Arab-Israeli War, when a Styx missile sank the Israeli destroyer *Eilat*.[76] The AAW system developed as a result, Aegis, is assessed as effective against cruise missiles launched from aircraft, submarine, and ships.[77]

To combat the cruise missile, naval critics generally agree upon the need for early warning aircraft, and the absolute requirement for air superiority--part of battlespace dominance--in joint littoral operations.[78] The Argentine pilots' success in approaching the British task force, frequently undetected, until within missile or bomb range, was attributed to a lack of early warning aircraft in the British naval

order of battle. American early warning architecture was designed to dcfeat Russian cruise missiles in mass raids. It should be able to meet the lesser threats of the post cold war era. Even so, the American Navy considers antiship cruise missiles its biggest threat.[79] This focus on antiair warfare fails to account for the greater lethality of torpedoes as compared to ASCM's.

The cruise missile seems overrated as a threat to littoral forces. It took five days for *Sheffield* to finally sink after two Exocet missiles hit her. In 1987, USS *Stark* was hit by two Exocet missiles. Though damaged, she returned to active service. No Coalition ships were hit or sunk by Silkworm cruise missiles during Operation Desert Storm. To sink a ship, a torpedo is a more lethal weapon. The *General Belgrano* sank less than an hour after being hit by two conventional torpedoes.[80]

Iran purchased two *Kilo* submarines from Russia for a reason. The U.S. Navy poses the biggest threat to Iran's control over the Persian Gulf. Iran need only deny the U.S. sea control to frustrate littoral operations in the Persian Gulf region. Iran's investment in diesel submarines signifies a decision to upgrade the lethality of its anti-ship weapons, in addition to its Exocet and Silkworm ASCM's.

American AAW capabilities render the cruise missile less of a threat than the torpedo to American expeditionary forces. To succeed in the littoral, the American navy must counter submarines and their torpedoes as effectively as it can counter antiship missiles. How the navy views the submarine threat can determine how successfully they defeat it.

Chapter III: DOCTRINE, THE NAVY VIEW

"Doctrine is the starting point from which we develop solutions and options to address the specific demands and challenges we face in conducting operations."[81] NDP-1

American Naval Doctrine

Historically, American naval doctrine has been unavailable in a condensed form. It was embedded in Naval Warfare Publications(NWP's) and policy statements, intermixed with tactics, techniques and procedures. Naval doctrine is undergoing formalization and publication in response to two stimuli: the emergence of Joint Doctrine, an outgrowth of the 1986 Goldwater-Nichols act, and the navy's strategic refocus outlined in the 1992 paper "...From the Sea."[82] This doctrinal transition is changing the focus of ASW from maintaining open SLOC's to establishing littoral battlespace dominance over submarines.

U.S naval doctrine is bounded by a desire to allow the decentralized operations, which historically characterized American naval warfare.

"Doctrine is conceptual--a shared way of thinking that is not directive."[83] *"Doctrine is not a set of concrete rules, but rather a basis of common understanding throughout the chain of command. Composed of 'shared convictions' that guide naval forces as a whole, it fuses our Service-unique tactics, techniques and procedures and warfighting philosophies."*[84]

Doctrine is written with the express intention of allowing commanders the freedom to solve problems effectively at the tactical or operations level. The historical foundations of the Navy's "shared convictions" on ASW provides insight to current ASW doctrine.

The Logic of Blue Water ASW Doctrine

America's strategic power projection across the world's oceans was opposed by submarine interdiction in both world wars. While convoys gave ships a measure of protection, they surrendered the initiative to the submarine.[85] Merchant ships were bait used to lure submarines into the escorts' detection and engagement range. Land based patrol planes provided offensive ASW measures within range of their airfields. The convoys' reactive posture demanded a new approach to establish control over sea communications. Hunter killer groups, built around ASW carriers, extended the detection and attack advantage land based patrol planes held over submarines to blue water operations. Seaborne ASW forces could now find and attack submarines before they launched torpedoes. The best defense against submarines was a good offense.

A new strategic threat arose during the cold war: nuclear submarines equipped with intercontinental ballistic missiles. The navy integrated land based patrol planes with long range underwater acoustic sensors, and quiet nuclear attack submarines to the combined arms, offensive ASW architecture of World War II.[86] Both systems exploited advanced technology to create favorable detection and engagement asymmetry over Soviet submarines. The patrol planes' large area search and localization, and the SSN's combination of ship quieting and advanced sonar virtually guaranteed first detection.[87]

The current employment of ship borne aircraft and helicopters for tactical ASW is a logical continuation of old blue water doctrine--find the enemy outside

his weapons range and attack him. Airborne radar's ASW role--detecting periscopes and surfaced or snorkeling submarines--remains unchanged. Forward Looking Infrared (FLIR) and night vision devices permit 24 hour visual search, denying submarines night time sanctuary for snorkel and surfaced operations.[88]

Improvements in Sonar power, receiver sensitivity, and sound manipulation reduce the effects of sound attenuation in water, increasing detection range. (See Appendix 1) The variable depth towed hydrophone array and helicopter dipping sonar isolate the hydrophones from ship generated ships noise, simplifying signal reception and classification.[89] The helicopter's speed and ability to set its hydrophone to precise depths increases effective search area and exploits the acoustic path to utmost advantage. (See Appendix 1).[90]

Cruise missiles, designed for submerged launch by nuclear attack submarines, created a tactical threat which combined ASW and AAW. SSN's regained the initiative they had lost, due to their its speed, acoustic advantage over surface vessels, and their ability to attack from beyond torpedo range.[91] Submarine launched cruise missiles (SLCM's) posed the Aegis system its most difficult challenge. Launched from below the radar horizon, it cut reaction time to a matter of seconds.[92] Missiles launched by ships and aircraft didn't require such short reaction time. Additionally, their launch platforms were easily as detectable hundreds of miles away, before they launched their missiles.[93] Yet the cruise missile did not replace the torpedo as the most lethal antiship weapon. The Soviet submarine fleet carried nine torpedoes for every SLCM.[94] They intended to finish

off any ship hit by a missile.

Soviet SSN's were countered by adding SSN's to American battle groups.[95] With the SSN as the overarching threat, diesel submarines became "lesser included threats."[96] Force protection through offensive means, predicated on American ASW forces acoustic advantage remained an executable doctrine while we held a technological edge and fought noisy submarines in deep water.[97]

However, even in a blue water scenario, self protection provisions are necessary in case ASW cannot meet a "zero defects" standard. Cruise missile protection was provided by the Aegis system, and a combination of jamming, chaff, point defense missiles, and/or guns, for non-Aegis equipped ships. Torpedo protection received less emphasis under blue water doctrine. Norman Polmar, an interested ASW professional, observes that

> "We countered the Styx sinking of an Israeli destroyer in 1967, ending with Aegis- will it take the sinking of one of our ships to come to grips with the torpedo?" [98]

The tradeoffs in ship design between adding weight for armor protection or minimizing weight in favor of speed and fuel endurance is as old steam driven ships. The U.S. Navy prefers fast, relatively light ships, relying on good offense and technology for torpedo protection. The Nixie and Prairie/Masker systems provide a partial solution.[99]

Nixie is an acoustic countermeasure designed to deceive an acoustic homing torpedo, causing it to miss. It is standard equipment on most American naval vessels.[100] One drawback is its ineffectiveness against conventional and

wake homing torpedoes. The Prairie and Masker systems use air bubbles to muffle propeller and machinery generated noise. They significantly reduce a ships acoustic signature. This provides three benefits: 1)Acoustic homing torpedo passive acquisition range is reduced. 2) The range at which submarines detect surface ships is reduced, lessening acoustic asymmetry between ships and submarines. 3) It reduces ship generated noise, thereby increasing the figure of merit for the ship's sonar. (See Appendix 1). Only escorts--cruisers, destroyers, and frigates--are built with Prairie and Masker systems.[101]

Active defensive measures against torpedoes were only recently (1987) funded for development.[102] The Surface Ship Torpedo Defense(SSTD) program uses a Mk-46 acoustic homing torpedo as an anti-torpedo torpedo.[103] The idea is similar to using a missile to shoot down a missile, the way ships defend themselves against cruise missiles. American missile defenses are layered: electronic jamming, missiles, chaff, and the Vulcan close in defense gun. Torpedo defenses rely on passive measures and an unproven point defense torpedo. Ships without torpedo tubes, including all amphibious ship, logistics ship, and MPS ship, are restricted to Nixie's deceptive measures. The vulnerability of escorted vessels to non-acoustic torpedoes creates a "zero defects" demand on ASW forces. They must preempt torpedo attack through offensive action against the submarine.

Amphibious and logistics ships, the vessels which permit power projection ashore "...from the sea," lack of sonar receivers and Prairie/Masker sound suppression systems. Only escorts and ASW aircraft have sonars capable of

detecting and classifying the acoustic signature of inbound torpedoes. The captain of an amphibious or logistic ship will remain unaware that he is under torpedo attack until alerted by an escort. The escort has to rapidly classify the sonar contact as a torpedo (or multiple torpedoes), then determine its (their) position, course and likely target. It must then fire its anti-torpedo torpedo without hitting the protected vessel. The shortage of escorts, driven by recent force draw downs, and the MK-46's short range, create the need for tight formations.[104] Unsuppressed noise from escorted vessels degrades the escorts' sonar performance, reducing the likelihood of a successful engagement.

The Navy's dissatisfaction with the Mk-46's shallow water performance raises doubts as to its reliably against targets much smaller than submarines.[105] One would assume that battle group commanders would demand better protective measures. The "shared conviction," or doctrine, of our battle group commanders hardly supports this concern.

A Naval War College study of 83 fleet exercises found that battle group commanders tend to focus on that which catches their attention.[106] ASW moves slowly. Strike warfare and AAW require rapid decision making and continual evaluation.[107] One carrier ASW veteran defined a typical commander's mindset:

> *"To a carrier, arguing with shadowy nuisances that hide underwater is the business of escorts...To get an offensive oriented carrier [captain] thinking defensively in an environment as foreign to its [his] nature as ASW, some continual adjustments are going to be necessary...If the carrier chain of command does not support the ASW effort, it is doomed to fail."*[108]

Many carrier commanders rise to flag rank and exercise profound influence

on Navy doctrine and policy: "the shared ideas." According to an experienced observer, they appear fixated on the idea that

> *"...all submarines are [or should be] detected and sunk in the outer Zone, none will leak through, and the threat will disappear. Unfortunately, more than 30 years of fleet exercise experience shows that a significant percentage of threat submarines will leak into the inner Zone."*[109]

The battle force commander is focussed on projecting power ashore--just like Admirals Woodward and Spruance were in their encounters with submarines in shallow water. The shared conviction of American admirals is that the premier threat to littoral operations is the ASCM. Most nations have far more aircraft and patrol boats than submarines; therefore, the logic goes, the ASCM is the greater threat.[110]

This point of view, coupled with force draw downs, has made an impact on current force structure and doctrine. The primary ASW escort vessel, the *Perry* class frigate, is being reduced in number form 39 to 12. The first two flights of the *Arleigh Burke* class guided missile destroyer(DDG) were built without organic ASW helicopters.[111] Production of the SH-60F and SH-60B, the Navy's tactical ASW helicopters, was cut back, with the last delivery to occur in FY 96.[112] The S-3B, an ASW patrol plane with a modern ASW suite, is replacing the A-6 as a tanker. The Tomahawk missile, F/A-18E/F strike fighter, and the antiballistic missile adaptations to the Aegis system receive the most budget dollars to support projecting power "...from the sea."[113]

Gazing at the Beach...From the Sea

"ASW is not an end in itself. It is a means through which we are able to conduct the missions required of us in this new world."[114]
Admiral William D. Owens, N8, 1993

While Admiral Owens' logic is sound, it understates ASW's importance. ASW is a component of every one of the seven Joint Mission Areas assessed as "the explicit link between required joint operational capabilities and Navy-Marine Corps programs and budget."[115] Neither Strike warfare, Antiair Warfare, nor Antisurface warfare fits all seven Joint Missions. The Navy may be creating a doctrinal paradox. While NDP-1 addresses the need to establish maritime superiority in order to project power ashore, the recent White Paper "Forward...From the Sea" reaffirms the intent to operate "...in the littorals, where we can influence events ashore from our sea bases in international waters."[116] The ordering of naval forces' five roles in support of the national strategy is revealing:

- Projection of power from sea to land
- Sea control and maritime supremacy
- Strategic deterrence
- Strategic sealift
- Forward naval presence

Sea control is *the* necessary precondition for projecting joint power from sea to land.

The Navy's conviction that it already possess command of the sea is reaffirmed by its resource allocation. For example, the FY-94 budget allotted

$1.64 *billion* for Theater Ballistic Missile Defense (TBMD), $34.5 million for SSTD, $51.1 million for low frequency sonar, and $13.0 million for non-acoustic ASW programs.[117] TBMD is moot if the ship assigned to the mission is sunk, or put out of action, by an underwater weapon.[118]

How The Navy Intends to Fight

> "*The Navy believes that the most likely [ASW] scenario will take place during a prolonged pre-hostilities period, and will involve 2-to-5 opposing subs.*" ADM William Owens, N8, 1993.[119]

The Navy's shared "conviction" foresees phasing an expeditionary campaign by clearing the sea of enemy submarines as a precondition for any land action requiring sea based logistic support. When the expeditionary force commander arrives, his major concern will be putting maximum combat power ashore in the shortest feasible time, to comply with the Joint doctrine of quick, decisive victory.[120] The rapid response of MPS resources during the recent Iraqi threats to Kuwait will not be possible if hostile submarines remain active.

ASW takes time to be effective. The likelihood that political leadership will allow a preemptive strike against submarines in port prior to hostilities is remote. If ASW forces are not allotted enough time to eliminate hostile submarines, an expeditionary operation can become desynchronized. Additionally, ASW forces pursuing submarines may not be able to provide the joint commander with Naval Surface Fire Support or Tomahawk launches.[121] The commander will have to decide to either wait, possibly jeopardizing his mission ashore, or gamble that the hostile submarines are as ineffective as the Argentine's were in the

Falklands. Given the need to "rapidly build combat power", he will be put in a position, similar to Admiral Woodward, of having to project power from the sea, into the torpedo danger zone. Without "zero defects" ASW, his entire operation will be in jeopardy.

Chapter IV: DOMINATING LITTORAL BATTLESPACE

"When you can't go where you want to, when you want to, you haven't got command of the sea." ADM Forrest Sherman, CNO[1950]

Assumptions

Two important assumptions effecting ASW in support of force projection are political constraints and enemy proficiency. Offensive ASW suggests that the best way to eliminate enemy submarines is to sink them in the harbor. Aggressor nations have the luxury of the first move, and American political beliefs generally rule out preemptive strikes. One can assume that defending diesel submarines will be underway and must be defeated by ASW forces.

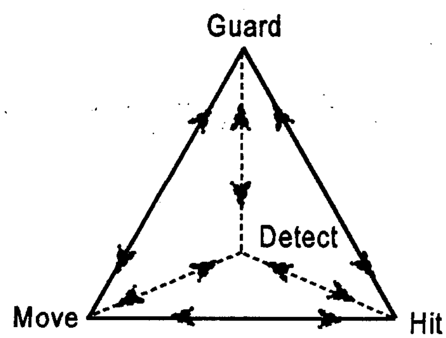
The American Navy assumes that poor training and inexperience will result in performances similar to *San Luis'*. Diesel submarines are expected to be found snorkeling "10 per cent of the time."[122] A trained crew needs 10-15 seconds of periscope exposure to collect enough information to grasp the tactical situation.[123] Third World submarines are assessed as requiring 2-3 minutes per periscope exposure to assimilate a tactically useful picture.[124] Despite the availability of advanced sonar systems, they also are assumed incapable of conducting blind submerged attacks.[125]

The assumption of high indiscretion rates conveniently minimizes the problem of finding a submarine by acoustic measures, since radar and visual sensors capitalize on submarines' indiscretions.[126] ASW forces have returned to the World War II paradigm of finding submarines with airborne radar. Initial detection

is the first step in solving the ASW challenge in shallow water.

War's fundamental functions are expressed in Fuller's Maxim for the Ignorant: "Guard, Move, and Hit."[127] The maxim is as applicable to ASW as it was to the land warfare that inspired it. A combat force must protect itself while hitting its opponent, move to create conditions for success and to deny the enemy an easy target, and hit the enemy to create a favorable outcome.[128] One rarely hits what one cannot sense, hidden movement facilitates surprise, and invisible hits are difficult to guard against.[129] Fuller's maxim can be amended to "Detect, Guard, Move, Hit" without violating any fundamentals.[130]

The Interaction of Fuller's Fundmentals



None of these fundamentals works in isolation. Their interaction is continuous. Effective hiding can force an opponent to expose himself. Hitting may force an opponent to move, impeding his own planned hit. Guarding counters a hit, permitting either a return hit or a move. Moving can negate an opponent's move, or reduce his capacity to hit and detect.

Interaction and Asymmetry: Detect

Offensive ASW doctrine has built a force designed to detect and hit submarines. Guarding against the submarine's hit receives little attention--the guard function is assumed by move and hit. If equipment meets doctrine's demands, expeditionary commanders will have the advantage of operating from a securc sea base. If not, the cncmy will have an opportunity to exercise sea denial. ASW forces must hit the submarine first to provide joint forces with littoral security.

Diesel submarines' batteries, their capacity to move submerged, require charging which makes them vulnerable to detection. Moving, and detecting expeditionary forces to facilitate their surprise hit, creates exploitable indiscretion. ASW forces must capitalize on this interaction in order to deliver a hit of their own. The navy expects radar to make initial detection of diesel submarines.

An aircraft conducting a radar search for an evading target can, at best, expcct a detection probability of 97 per cent if it uses a coverage factor of three(considered high).[131] Human factors modify this down to about 73 percent. Studies have shown that radar and sonar operators experience a 25 per cent degradation of valid contact recognition in the first 30 minutes of a watch or mission.[132]

Radar contact interpretation requires time. Even Inverse Synthetic Aperture Radar(ISAR), which can identify and classify radar contacts beyond visual range, requires subjective classification--a process prone to human error.

ISAR image interpretation is a perishable skill, requiring intensive training. The documented difficulties in operator training cannot benefit from current budget reductions.[133] Furthermore, the radar operator's assumed two to three minutes for contact classification is shrinking.

Tactically dangerous periscope exposure does not require British "Perisher" training to overcome. A technical solution is available now. Masts integrating low light TV, EW antennas, periscopes, and video cameras replace the conventional periscope.[134] A submarine commander can put his periscope up in any light condition, traverse the scope through 360 degrees, and bring the scope down in less than a minute. He can then analyze video taped imagery while remaining unexposed. The performance gap between untrained and trained crews, which the U.S. Navy is counting on, is closing. While radar may acquire a submarine committing an indiscretion, even best case searches cannot comply with the "zero defects" ASW requirement. Initial submarine detection using acoustic sensors, the blue water paradigm, must augment radar and visual search.

Surface forces are at a considerable disadvantage while moving from deep into shallow water during force projection. The ships critical to power projection, amphibious and logistics ships, and aircraft carriers, create acoustic signatures detectable at long range.[135] The relative quiet of escorts is negated by the need to use active sonar for initial detection. This alerts the submarine, providing it with both initial detection data, the criteria to commence evasion, and the advantage of detecting ASW forces without having to expose itself. Should active sonars get too

close, a diesel submarine can hide without moving in shallow water by settling to the bottom--a technique unusable in deep water.

Interaction and Asymmetry: Hit

The submarine is most vulnerable to detection just before and during its attack. The submarine captain will expose his periscope to confirm his firing solution and identify any escorts maintaining sonar silence. The torpedo or missile he launches creates an acoustic or electromagnetic signature.[136] Detection asymmetry virtually assures that the submarine scores the first hit. The naval force's ability to guard must counter this. But "guarding" depends upon "detecting" and "hitting" the submarine. The paradox of current ASW equipment and doctrine is that the ASW force's best opportunity to detect and hit the submarine is during the submarine's hit, after they fail to guard.

"Hit" asymmetry favors the submarine. Ships and aircraft must refine a firing solution in the three dimensions of distance, bearing, and depth. The submarine need only solve fire control geometry in two dimensions, bearing and range--depth is defined by the target's draft. The submarine can also launch its torpedoes form a longer range.(See Appendix 1.) Its challenge is to make the first attack and evade counterattack. In a study of ASW attacks conducted under intense conditions, researchers found that an average of three erroneous attacks were conducted for every valid one. Furthermore, eight per cent of the valid active sonar contacts were classified non-sub, and therefore not attacked.[137]

Hitting in shallow water favored the submarine in the Falklands. *San Luis*,

Conqueror, Spartan, and *Splendid* all maneuvered into good firing positions against surface targets.[138] *Conqueror* sank *Belgrano* from point blank range.[139] *San Luis* sank nothing due primarily to mechanical malfunctions originating in the submarine, and, to a lesser extent, crew inexperience.[140] The British escorts, using nearly their entire store of ASW torpedoes, scored no hits. In some cases, this stemmed from attacking non-submarine contacts. Fundamentally, it was due to their inability to detect and track *San Luis* with sufficient precision to place their weapons close enough to *San Luis* to acquire and hit her.[141]

In the twelve years since the Falklands war, the U.S. Navy has not developed a reliable, air or ship launched, shallow-water anti-submarine torpedo.[142] The submarine holds the advantage of firing the first salvo while undetected, and current weapons cannot be counted on to hit enemy submarines even when they are detected. Other means are necessary to establish littoral battlespace dominance, since expeditionary forces cannot move freely if they can neither detect, guard, nor hit better than the submarine. Both high and low tech solutions are available.

The High Tech Solution: Subs and Sonars

America's deadliest blue water ASW weapon--the SSN--deserves consideration. Under certain conditions, SSN's are very effective at detecting diesel submarines, and sinking them, in shallow water before expeditionary forces arrive to project power ashore. SSN's are not strangers to the littoral waters.

> In the past twenty years, American submarines have logged over 14,000 real-world submerged submarine days in water less than 600 feet deep.[143]

However, SSN's operate under tactical limitations when they perform shallow water ASW in advance of force projection operations--the least of which is their lack of acoustic advantage and restricted maneuverability discussed previously. Short strategic reaction time and fratricide prevention further limits their optimal use in the combined arms ASW team. The recent drawdown, from over 100 SSN's in 1988 to "45-55" SSN's by 2001, dramatically reduces the number of forward deployed SSN's available to react quickly to strategic decisions.[144]

American decisions to conduct force projection tend to be strategically reactive. The United States' historical shortcomings in foreseeing crises and taking timely action contradicts the assumption that SSN's will have time to fight a covering force battle against diesel submarines during the "extended pre-hostilities period" envisioned by naval leaders.[145] Early entry forces, including carrier battle groups(CVBG's), amphibious ready groups(ARG's), and prepositioning ships, will rapidly arrive in the AO to provide the CINC with combat power. Finding a diesel submarine in shallow water takes time and patience. Time may be in short supply.

ASW forces arriving with CVBG's must discern between friendly and hostile submarines. American taboos against fratricide necessitate tight weapons control measures. Attack opportunities lost during " identification friend or foe"(IFF) negate the offensive hits required to guard against torpedo attack. If SSN's can't practice "zero defects" ASW during the short "pre-hostilities period", they will require autonomous patrol sectors, like the British used in the Falklands, to permit all ASW forces to comply with offensive ASW doctrine by attacking

every submarine they find.

Other high tech measures, sonars with detection ranges two to three times longer than current equipment, are under development. They will not arrive in tactical units until after the turn of the century. The same is true for SSN identification systems--they are under development, but not in general usage.[146] Until these systems and improved non acoustic sensors reach the fleet, defending diesel submarines will retain favorable detection and attack asymmetry over American forces.

A Low Tech Solution to Asymmetry

Sound, the defending submarine's primary source of long range tactical ship detection, can be manipulated to provide a low tech solution.[147] The Prairie and Masker systems installed on escorts greatly reduce the submarine's sonar counter detection range against escorts.[148] The fundamental interaction caused by reducing initial detection profoundly alters the ASW problem. This technology should be applied to noisy power projection ships.

Masker systems can be installed using off the shelf equipment.[149] Reduced acoustic signatures would provide defending submarines with shorter initial detection ranges, forcing them move more often to cover a given search area. This reduces battery charge, driving patrol endurance down and indiscretion up. Higher indiscretion yields greater detection opportunity for ASW forces, increasing opportunities to hit--the necessary precondition for fulfilling the "guard" function.

Quieting amphibious and logistics ships was rejected during the cold war--

even though the risk of using them as bait in blue water ASW was as great a risk to reinforcing Europe as it is to current power projection imperatives. Using amphibious and logistics ships as bait cost the Allies over 2800 ships during the Battle of the Atlantic. The U.S. Navy expects to operate 41 amphibious ships and 65 logistics and support ships for the next ten to twenty years.[150] The nation cannot sustain heavy losses and expect to win quick, decisive victory. Quiet ships make less vulnerable bait.

If the quieting option is again rejected, "bait" security can be improved by integrating torpedo tubes and passive hydrophones into amphibious and logistics ships' combat systems to provide close in defese against torpedoes. This option is contingent upon the successful development of SSTD. There is no guarantee that an anti-torpedo torpedo can be successfully developed.

The Bottom Line

Even if better systems and quieter ships are deployed, ASW escorts lack the necessary tool to fulfill their joint force projection mission--a shallow water ASW weapon they can count on. Offensive ASW remains the strategic imperative of power projection. The fundamental functions of war will not change in the near future. The water volume around an expeditionary force needs to become a torpedo danger zone for the submarine.

If ASW forces cannot hit diesel submarines with their ASW weapons, submarines will survive counterattacks and return to the littoral AO to reattack--just like the *San Luis* did off East Falkland. The U.S. Navy cannot count on luck or

"inexperience" to defend a joint force commander's precious seaborne logistic and combat assets. If, due to fiscal constraints, only one program can be funded to improve the ASW "guard" function, the U.S. Navy should spend its money on an air and ship launched antisubmarine weapon that works. Under offensive ASW doctrine, "hitting" defending diesel submarines is the best way for ASW escorts to guard joint expeditionary forces, projecting power "forward . . . from the sea"--into the torpedo danger zone.

Endnotes

1. Rosinski, Herbert The Development of Naval Thought Ed. Mitchell Simpson III. Newport: Naval War College Press, 1977. p. 137. Quoting Winston Churchill's remarks to theHouse of Commons, 16 October 1943.

2. ADM Carlisle A.H. Trost, "Interview With Admiral Carlisle A.H. Trost," (author unnamed) Proceedings June 1990, p. 69.

3. Charles W Mayers, CDR, USN "Looking Back Into the Future of the Maritime Strategy, Are We Uncovering Our Center of Gravity in the Attempt to Strike at Our Opponent's?" Naval War College Review Winter 1989 p. 33-46. Mayers shows that some proposed sequels of the maritime strategy predicated taking the offensive to the Soviet Union from the sea. This would include power projecting into Soviet home waters, defended by a fleet of over 200 diesel electric submarines. The U. S. Navy never addressed how they would neutralize that threat. Considering the lethality of modern war, it was unlikely a war would reach this phase. The impetus to solve the shallow water ASW problem never materialized, nor received funding of other, more likely combat needs.

4. Tom Stefanick, Strategic ASW and Naval Strategy Lexington: D.C. Heath, 1987, p 10-13. These concerns were recently raised by Les Aspin, Secretary of Defense, in his Annual Report to the President and the Congress. Washington, 1994. This is a generally held view in the American ASW community. Naval message AIRTEVRON ONE 011201Z NOV 94, para 3: "Sensors and weapons currently in use have limited capability in the littoral environment." The physical reason is simple: acoustic sensors detect nuclear subs by discerning machinery noise associated with running a nuclear reactor and large steam turbines, as well as propeller cavitation. With the Japanese transfer of nine-axis milling machines to the Russians, very quiet propellers were made and which caused huge consternation among the American ASW community. (Ralph K. Bennet "Toshiba, Anatomy of a Betrayal" Reader's Digest Dec 1987, p. 100.) Diesel subs only have an electric motor running the propeller when on battery. They tend to operate below the "quiet speed" of 8-12 knots in order to conserve their battery charge. This does not generate sufficient noise to overcome the acoustic clutter in typically noisy shallow water. A further limitation of shallow water is the lack of deep water acoustic ray paths, which transmit sound much further than direct transmission. See Stefanick, Appendix 4.

5. Hon. Sean, O'Keefe, ADM Frank B. Kelso,II, USN, and GEN Carl E. Mundy, USMC, " ...From the Sea: Preparing the Navy for the 21st Century. " Department of the Navy, Washington DC 1992. In an interview, Sean B. O'Keefe, "Be Careful What You Ask For..." (Interviewer unnamed) Proceedings Jan 93, p.73), Secretary O'Keefe claimed "We have sea control covered at this point."

6. ADM William A. Owens, USN, "ASW: Still A Priority," Interview by John F. Morton" Proceedings , Mar 1993 p.124: "ASW is not the number one priority any more." ADM Owens points out that "ASW is not an end into itself. It is a means through which we are able to conduct the missions required of us in this new world."

7. Hon John H. Dalton, ADM Jeremy M. Boorda, USN, and GEN Carl E. Mundy, USMC, "Forward... From the Sea" Department of the Navy Washington, D.C. September 1994. See also the Secretary of Defense "Annual Report to the President and Congress, January 1993. p. 84 "Although the pace of ASW has declined with the reduction of the deep water submarine threat, the shallow littoral operating environment presents new challenges." and the 1994 Report, p. 166., "Threat...the most worrisome are anti-ship cruise missiles, which are becoming increasingly available around the world through foreign military sales."

8. "A Strategy of Engagement and Enlargement" National Security Strategy of the United States Washington, 1994. Freedom of the high seas is not addressed anywhere in this document, though issues contingent upon it, like international trade, are covered in great depth. There may be valid political reasons for avoiding the freedom-of the-seas issue. The 1982 United Nations Law of the Sea convention proposes an economic interest zone of 200 nautical miles. The United States does not acknowledge this, since it could easily escalate into nations attempting to enforce a 200 nautical mile territorial limit- like Ecuador and Peru did in the 1970's. We recognize a 12 nautical mile limit to territorial waters, and maintain that freedom on the high seas is necessary for healthy international commerce. For a commentary on this , see Alfred Nien-Tsu Hu & J.K. Oliver "A Framework for Small Navy Theory: The 1982 United Nations Law of the Sea Convention." Naval War College Review Spring 1988 p. 37-48. As to our assumptions, see "Be Careful of What You Ask For...": Interview with Secretary of the Navy Sean O'Keefe" Proceedings Jan 1993 p. 73-74. O'Keefe asserts that "...From the Sea's fundamental assumption is that there is no potential belligerent who has the ability to challenge us in the open sea." That may or may not be true, however an enemy can still wreck our minimalist force structure with the selected sinking of a few important high value units. For the freedom of navigation issue's relative importance, contrast Defense Secretary Cheney's 1993 Report to the President and Congress with Secretary Aspin's 1994 Report-- in the former, freedom of navigation is laid out in the naval missions section, stressing its importance how much we did. In the latter, it is consigned to the last Appendix(G), and uses less powerful language.

9. Julian S. Corbett, Some Principals of Maritime Strategy Annapolis: Naval Institute Press, 1988, (Original edition, London: Longmans, Green and Co. 1911) pp. 104-105 & p. 319.

10.Corbett, p. 165; "When our relative strength is not adequate to secure command [of the sea], we have to content ourselves with endeavouring to hold command in dispute...by active defensive operations to prevent the enemy from either securing or exercising control [of the sea]." According to Corbett, a nation on the receiving end of our force projection strategy need not control the sea to defend a littoral area. It is sufficient to deny local sea control to the enemy [the US]. The historic asymmetry between submarines and the antisubmarine forces required to neutralize them has not changed. "It takes 100 antisubmariners per submariner too defeat the submarine threat". NDP-1, p.56. As demonstrated in the Falklands, a small number of submarines can still achieve local sea denial against a much larger force.

Clausewitz asserts that the defense is the stronger form of warfare, while the offense is the decisive form. von Clausewitz, Carl On War Translated and edited by Michael Howard and Peter Paret (Princeton: Princeton University Press, 1976), p. 365. Corbett, p. 325, agrees with this view. Investing in diesel submarines for littoral defense is logically sound, considering the fiscal limits on any nation's naval budget. A Russian Kilo or a modern Dutch diesel submarine, the *Walrus* class, can be purchased for the cost of a modern frigate-- yet it takes multiple frigates and aircraft to find and subdue a submarine. China recently ordered three Kilo class submarines from Russia for about $250 million per copy. See Norman Friedman, "World Navies in Review," Proceedings Mar 1994, p. 114. According to the USNI database, the Dutch navy paid $221 million per submarine for the *Walrus* class. The Australian Navy paid about $250 million for each of 4 *Perry* class frigates-- not including the SH-60B helicopters, which the US Navy has found to be indispensable to the success of that class. The Swedish Navy paid $430 Million for 3 *Gotland* Class submarines(about $145 million each). These subs displace 1155 tons, roughly the same size as the Type 209 *San Luis*, and have AIP Stirling engines which use LOX to provide air for the diesel engine. Argentina, India, Indonesia, South Korea, Brazil, Chile, Colombia, Venezuela, Peru, Greece, Turkey, Ecuador and Israel all operate Type 209's. The hull displacement varies from 1200 to 1500 tons, depending on the year delivered and the options desired. Source: USNI Database, 1994, Ships, Submarines. As a bonus to medium and small navies, the diesel submarine's role is not restricted to defense--its capabilities are well suited for offensive operations against local threats.

11. NDP-1, pp. 20 & 27.

12. NDP-1, p. 63.

13.Nations not upgrading their submarine fleets, either through modernization or new equipment purchase, are Albania, Egypt, Cuba, Venezuela, Colombia, Ecuador, Rumania, Syria. Source, USNI Database, 1994, Ships, Submarines,, review by the author. This trend is also apparent when reviewing

Jane's Fighting Ships, 1993-1994.

14. The total number of MSC ships available varies: 19 LMSR (8 used for prepositioning, see below); 19 RO/RO ships (12 active, 7 in procurement); 35 prepositioning ships (13 for the Marine Corps MPS, 10 for the Army MPS; the remaining 12, including 4 ships full of Air Force equipment, carry fuel, munitions and medical equipment/supplies); and 22 oilers which currently service the fleet. Additionally, 76 Ready Reserve Force(RRF) cargo ships and 11 RRF tankers are available within 180 days after mobilization. Currently , some of the active MSC ships are RRF ships which are chartered from Maritime Administration (MARAD), a Department of Transportation(DOT) organization. Secretary of Defense "Report to the President and the Congress, 1994." p. 202-209.

15. This is a fairly well agreed upon by most military planners, though open to some fluctuation with METT-T. For example, over 85% of lift was by sea in Desert Shield/Storm; see Annual Report to the President and the Congress, , 1991, p. 13. Force 2001 puts the figure closer to 95%... In any case, there is great reliance on seaborne lift. For serious force projection, particularly with MPS assuming greater emphasis, the sea's remain the LOC of necessity--absent a buy of thousands of C-17's.

16. For a humorous vignette and discussion of the friction inherent in ASW, read ADM Sir John Woodward's description of a two hour sub hunt, which turned out to be whale chasing, near Ascension Island on the way to the Falklands. ADM Sir John Woodward , with Patrick Robinson, One Hundred Days, Annapolis: Naval Institute Press, 1992, p. 98.

17. Polmar, Norman "Countering Torpedoes" Proceedings Dec 1989 p. 119-122. Polmar suggests that The Russian 65cm wake homing torpedo is immune to current counter measures. Norman Friedman agrees: See "Start Worrying About Wake-following Torpedoes" Proceedings, Sept 1994 p. 123-124; "Wake following matters because it is not susceptible to the simple countermeasures navies currently deploy." With a range of 27 nm at a speed of 50 knots, they expand the torpedo danger zone immensely. Russian cash flow demands could drive the export of this weapon. The French have also developed and deployed a wake homing torpedo--given past French behavior, a technology export risk. See also Norman Friedman, "Russian Wake Homers for Sale," Proceedings, June 1993.

18. COL J.F.C. Fuller, The Foundations of the Science of War London: Hutchison & Co., Ltd.,1926. (Reprint Fort Leavenworth, KS: USACGSC Press, 1993.), p. 335.

19. ADM Kinnard R. McKee, (Ret), (successor to ADM Rickover as czar of nuclear power and nuclear submarines), quoted from "McKee Sees Different

Mission For Future Attack Submarines," Proceedings Sep 1990, p. 82, His quotation regards how both submarine and ship captains would need to reassess their assumptions when operating against non-nuclear submarines.

20. I use the term 'Falklands/Malvinas" to emphasize that the typical American view has been focussed on the "winners," the United Kingdom, with whom we have a special relationship. I do this in unabashed imitation of ADM Harry Train, II, USN(Ret), in his "An Analysis of the Falklands/Malvinas Islands Campaign" Naval War College Review Winter 1988 p. 33-50.,(Transcript of first Annual Hoffheimer Lecture to students, faculty, and military guests at Armed Forces Staff College, Norfolk Va.)

21. Some ASW practitioners are concerned that too much of a battle group commander's attention is diverted to Strike Warfare, Antisurface Warfare (ASUW) and Anti-air Warfare(AAW)--at the expense of ASW. See Walker, William B. "Where Are the Tactics?" Proceedings July 94 P. 26-30.; LCDR D.F. Glick, USN, "Is The Battle Group Commander Really Concerned About The Threat of a Submarine Launched Torpedo?" Naval War College Newport, RI. 18 Feb 1987; and LCDR Scott Kelly's "Carrier ASW, Can Do!" Proceedings Jun 1990, p.74-78.--*or ask any ASW practitioner you meet!* KAR.

22. ADM Samuel Eliot Morison devotes about a page in Rising Sun in the Pacific, 1931- April 1942, vol. 3, The History of United States Naval Operations in World War II (Boston: Little, Brown, 1948). CDR Walter Karig, USNR, and LT Welbourn Kelly, USNR, in Battle Report: Pearl Harbor to Coral Sea (New York: Rinehart and Company, 1944.) gives the raid two pages, in as well as overstating the damage sustained by the Japanese Thomas B. Buell gives a thorough description of the planning, execution, and aftermath of the raid in The Quiet Warrior: A Biography of Admiral Raymond A Spruance (Annapolis: United States Naval Institute Press, 1987), pp. 110-121.

23.Buell, p. 116.

24.Buell, p.117.

25. In Spruance's defense, this action took place early in the war, when his confidence in the reliability of his pilots' and sailors' spot reports may have been justifiably low. Buell discusses how Spruance and the captain of the *Salt Lake City*, Capt Zacharias, entered the mission with a different IPB--Zacharias was certain there were submarines at Wotje. Buell, p.117. One could charge Spruance with being clumsy with the use of air assets-- his cruisers' spotter planes could have been assigned an ASW role. Ignoring the fact that they were critical sensors in effective WWII naval gunnery, the raid's primary focus, this would be a case of

using current doctrine as a template over past events-- which are often steps in the discovery process of sorting out which TTP's work and which do not. It also ignores Spruance's adroit handling of aircraft carriers at Midway four months later.

26. This saying takes a number of forms, but I have heard it and its companion phrases, such as "A collision at sea can ruin your entire day" and "The trouble with a fire at sea is that, to fight it, you pump water into a ship-- which was designed to float by keeping water out-- and run the risk of sinking/dying anyway!", since I was a midshipman at the Naval Academy.

27. Louis Gerken, Submarine Versus ASW Technology Battle (Chula Vista: American Scientific Corporation, 1986.) p.52. It is ironic to note that the carrier was on an ASW mission at the time of the attack.

28. Gordon W. Prang, collaborated with Donald M. Goldstein and CW4 Kitherina V Dillon, USAF, At Dawn We Slept: The Untold Story of Pearl Harbor (New York: McGraw Hill Book Co., 1982), p 509& p. 513. Two torpedoes hit USS Oklahoma, and then a third did the coup de grace. USS California's rapid sinking, facilitated by numerous hatches being open in preparation for an inspection, was caused by two torpedoes. The fact that these torpedoes were launched by airplanes is immaterial: torpedoes did not require hits on ammo magazines or fuel stores in order to sink a ship. It is simply a matter of letting water in below the water line and starting fires which cause more water to be pumped into a ship.

29.ADM Samuel Eliot Morison, History of United States Naval Operations in World War II, vol. 4, Coral Sea, Midway, and Submarine Actions May, 1942-August 1942 pp. 134-135 .

30. ADM Samuel Eliot Morison, History of United States Naval Operations in World War II, vol 5: The Struggle for Guadalcanal Boston: Little Brown, 1948. pp. 130-138. On 15 September, 1942, *USS Wasp* was escorting transports containing the 7th Marines to Guadalcanal. She obviously failed in her ASW mission-- the Japanese submarine *I-19* fired a spread of 4 torpedoes, scoring three hits. *Wasp* was abandoned and scuttled due to the uncontrollable fires and unseaworthiness resulting from the torpedo hits. The battleship *South Carolina* was hit, though not sunk, by *I-15*, in this action.

31. ASW hunter-killer groups did not appear in the American naval order of battle until 1943. Nimitz & Potter Sea Power: A Naval History, second ed. (Annapolis: Naval Institute Press. 1981), p. 268 .

32. A detailed study of the genesis and developments of both submarines and ASW can be found in Gerken's ASW Versus Submarine Technology Battle. It

is already somewhat dated in that it addresses neither current AIP submarines nor sub- launched Exocet and Harpoon commonly found in many navies. It is a good source for understanding problems facing ASW practitioners.

33. Books offering comprehensive coverage of the conflict include Max Hastings and Simon Jenkins Battle for the Falklands (London: Michael Joseph, 1983,). and Martin Middlebrook's The Fight For the Malvinas (London: Penguin Books, 1989) and Operation Corporate (London: Viking Books, 1985).

34. Woodward, One Hundred Days, p. 105. Woodward notes that he was too far from Ascension Island to get MPA support from Nimrod aircraft, and had no patrol craft on his carriers. So long as American carriers are present, S-3B aircraft provide battle groups long range ASW patrol. KAR.

35. *HMS Onyx*, S21, was the lone diesel submarine deployed to the Falklands. Hastings, Max and Simon Jenkins. The Battle for the Falklands (New York: W. W. Norton & Company, 1983). p.38, Appendix 2. According to the 1994 USNI Database *Onyx*, an *Oberon* Class diesel sub, class has a range of 9,000 nm at 12 kts surfaced and an endurance 50+ days). Compared to the *Swiftsure* class SSN's employed, *HMS Spartan* and *HMS Splendid*, whose speed is assessed at 30+ knots, and whose endurance is virtually infinite-- food being the critical resupply issue-- one can see why diesel subs were not an optimal good power projection choice. It had to transit on the surface for 8000 miles, and arrive on station virtually out of gas after 31 days. The SSN's arrived in about two weeks, with a full load of fuel, and hardly a dent in their 15 week food supply.

36. Train, "An Analysis of the Falkland's Malvinas Campaign," p. 35.

37. Woodward, p. 160. The fact that the destroyers did not have their sonars "switched on," actively pinging, and their "dawdling pace" of 13 knots does not necessarily prove, as Woodward contends, that the Argentines were blissfully ignorant. An active sonar is counter detectable well beyond it's useful detection range. Explanations for the slow Argentine speed, lack of zigzagging, and sonar silence can include fuel conservation, and a focus on passive sonar listening coupled with emissions control to avoid detection. Increases in ship's speed generates considerable noise, reducing a hull mounted passive sonar's detection range. (See Appendix 1).

38. Robert L. Scheina, "The Malvinas Campaign," Proceedings May 1983, p. 117.

39. Woodward observes that *Conqueror* was in position to attack the two destroyers within a few hours of evading their counterattack. *Conqueror's* captain had opportunities to attack on subsequent days, however, in light of their

preoccupation with rescuing survivors from *Belgrano* and their departure from the AO, he decided "to keep Conqueror in one piece rather than attempt further heroics." One Hundred Days, p.163. See also Middlebrook, Operation Corporate, pp. 147-150 regarding *Conqueror's* perspective. In The Fight for the Malvinas, p. 98, Middlebrook points out that *Conqueror* had frequently been in attack position prior to 1 May, but was not authorized to attack-- it took satellite communications with London to get "Weapons Free!"

40. Battle for the Falklands, p. 38 and 39 of Appendix 2. While *San Luis* never faced more than 3 escorts and 5 helicopters at any one time, the presence of a large number of ASW escorts meant that any time *San Luis* got away from one group of escorts, others were still between it and the British helicopter carriers.

41. ADM Train overstates *San Luis'* role in when he asserts that "It dictated, at least as much as the air threat, the conduct of British Naval operations and caused expenditure of a vast supply of ASW weapons." While the Royal Navy certainly filled the ocean with ordnance, Woodward's tone throughout One Hundred Days reflected greater concern with the cruise missile threat. His determination to deal with ASW as it arose and stick to his mission, and the aggressiveness of British ASW efforts, stands in contrast to his frustration with ROE--The decision to attack the *Belgrano* task group outside the Total Exclusion Zone(TEZ) had to come from London.

42.Woodward, p. 56.

43. One Hundred Days, p. xxiii. See also Operation Corporate, p. 157. Numerous critics have agreed with Woodward's assessment of the threat hierarchy--after the fact, of course.

44. Of four Argentine submarines, two were unseaworthy, and one disabled while supporting special operations on South Georgia Island-- so *San Luis* faced the British flotilla alone. The Argentine submarine *Santa Fe* was caught on the surface by armed helicopters. Among the reasons, apart from damage to the sub, the captain failed to dive was fear that acoustic homing torpedoes would have a better chance at destroying it under water-- so he stayed on the surface! He was later court-martialed for having been caught on the surface. Middlebrook, Operation Corporate pp. 109-110. Ironically, Woodward's diary entry for the night of 24 April confessed his concern that the South Georgia operation, conducted by a four ship task group under *HMS Antrim,* had "bogged down for fear of an Argy *submarine [Sante Fe*]" He notes that on the 25th, his reaction upon learning *Sante Fe's* fate was that it was a "miracle." Woodward, p.105.

45. Woodward, p. 98. An Argentine Type-209 sub had once transited from Argentina to Ecuador, a much farther distance. There was also legitimate concern

in 1982, during the height of the Cold War, that a Soviet SSN would "shadow" the British battle group to observe their operations, and perhaps intervene on the Argentine's behalf.

46. Woodward, p. 6.

47.Woodward, pp. 104-105. Part of the problem in any ASW operation is ascertaining the true identity of a given underwater contact . It generally requires extended tracking or multiple sensors to determine whether or not a sonar contact is a submarine, or some other underwater phenomenon. The period during classification can be extraordinarily tense for the ship concerned during peacetime exercises-- in a shooting war, the tension heightens and frequently elicits a higher false contact rate. An interesting study on this phenomenon, and its ensuing impact on the attack decision can be found in Robert R. Mackie and C. Dennis Wylie, Attack Decision Making in Surface Ship ASW: Historical, Theoretical and Experimental Data (Human Factors Research Inc, Goleta CA. 1973.)

48. Woodward, p. 17.

49. The Royal Navy's role in NATO was heavily biased toward ASW due to its size and proximity to the Soviet Unions sea avenues of approach, the G-I-UK gap. Its failure to find a diesel submarine caused some concern over NATO assumed ASW effectiveness.

50. Woodward makes a variety of references to accidentally killing whales with ASW weapons. The captain of *San Luis*, Commander Azcueta, assessed his 4 May attack against a submerged sonar contact as having most likely been against a whale. Middlebrook, Fight For the Malvinas, p. 126.

51. Train, p.40. James Fitzgerald and John Benedict claim, in in "There is a Sub Threat" Proceedings, Aug 1990, p. 58., that the British expended over 200 pieces of ordnance, "...including numerous depth charges and large number of homing torpedoes, the majority of which exploded amidst a sea full of false contacts." Mackie and Wylie, *supra* note 30, assert that the ratio of false attacks to valid attacks average about 3 to 1. They also found that 8% of valid contacts were not even attacked.

52. To reconstruct the ASW effort against *San Luis*, a variety of unclassified sources were consulted, including One Hundred Days, two Proceedings articles by Robert Scheina; "Where Were those Argentine Submarines" Mar 1984, p. 115- 120, and "The Malvinas Campaign" May 1983, p. 98-117.; Office of Program Appraisal Lessons of the Falklands: Summary Report. Department of the Navy, Washington, DC. 1983.; CDR C.J. Lokkins, Falklands War: A Review of the Sea-Based Airpower, Submarine and Anti-

Submarine Warfare Operations Air War College, Maxwell AFB, AL. 1989; John J. Mackin, The Submarine in Low Intensity Conflict: Lessons From the Falklands. Naval War College Newport RI 1990, and ADM Harry D. TRAIN, ,II, USN(Ret). "An Analysis of the Falklands/Malvinas Islands Campaign" Naval War College Review Winter 1988 p. 33-50. Middlebrook's Fight For the Malvinas generally concurs with Scheina's accounting .

53. Kipp, Naval Art and the Prism of Contemporaneity: Soviet Naval Officers and the Lessons of the Falklands Conflict , p. 18.

54. Lokkins, p.15, and NDP-1, p.32.

55. The situations were not identical. The World War II convoys were tailored for ASW operations and operated under conditions of air superiority against submarines in an offensive mode. The notable exceptions being the Murmansk convoys, which suffered from effective combined arms attacks by German submarines, aircraft, and ships. MAJ James A. Davidson, USAF, "Der Unterseeboote Norwegen: An Analysis of the War Journals- -German Submarine Commander in Norway WWII" Naval War College, Newport R.I. Feb 18, 1987. provides a profound insight into the effectiveness of combines arms formations in the maritime interdiction role.

56. Naval message, AIRTEVRON ONE 011201Z NOV 94 (UNCLAS) Addressed to CNO and all ASW activities. Subject: Summary of Littoral Air ASW Conference held at VX-1, Patuxent River, Md, 11-14 October 1994. Paragraph 3. VX-1 is the air ASW equipment test and evaluation squadron.

57. Kipp, p. 18. A parochial submariner's view of this issue can be found in RADM W.J. Holland, Jr., USN (Ret) "SSN: The Queen of the Seas," Naval War College Review, Spring 1991, p. 113.

58. Gerken, p. 291. It took 21 months and the reforms aggressively sponsored by Admiral Lockwood to get a reliable torpedo into the fleet in 1943.

59. Woodward, pp. 122-127. This was the mission as seen from the Battle Group Commander's point of view. The reality was that the submarines were being controlled by Admiral Northwood-- in London. This led to taskings from echelons above Woodward which disrupted his submarine deployment plan, including the preemption of *Spartan's* mission against the *Veintecinco de May.* Admiral Woodward accepted this command relationship "with as much grace as I could summon, which as I recall, was not all that much."

60. In the case of the aircraft carrier *Veintecinco de Mayo*, the SSNs' task was to either sink it, or disrupt its operations so that it could not launch its attack aircraft. While light winds were what actually preempted carrier operations on May 2 and 3, the SSN's had the opportunity to sink it...however the command and control arrangements noted above (*supra* 59) precluded their making an attack.

61. Middlebrook, Fight for the Malvinas, p. 105.

62. According to Woodward, p. xviii, the sinking of one of his major vessels by the *San Luis* would have caused his operation to culminate. His assessment of how badly *San Luis* was handled; i.e. "..her CO would never have passed a British Perisher." p. 147.

63.Woodward, p. 124. *Conqueror* was assigned the quadrants southwest and southeast of the Falklands. I estimate the patrol areas at about 100nm by 200 nm, considering the approach paths of to the Task group, the amount of air surveillance available to the British, and the multitasking laid on the SSN's by higher level HQ's. *Spartan* and *Splendid* were assigned to the quadrants north east and north west, since that was where the bulk of the Argentine navy would come from. Woodward expressly forbade his sub commanders from attacking sub surface targets-- depriving himself of his best ASW platform, but also ensuring no blue-on-blue engagements by his ASW forces. (p. 123.)

64.The Russian *Kilo* and the German Type-209 submarines are two of the most popular and capable submarines available on the international arms market. The *Kilo* class is recognized by Admiral Owens, current Deputy Chairman of the Joint Chiefs of Staff, as "A hardy submarine...able to be down at 2 or 3 knots for a long period of time and snorkeling only after 2 or 3 days." "ASW: Still a Priority."Proceedings March 1993 p. 127 The *Kilo* class is currently operated by the Indian, Russian, Iranian, Algerian, Rumanian, and Polish navies. The Type 209, *San Luis*, was a success story for the Argentines--in stealthiness and survivability. (The weapons control problems have no doubt been addressed since 1982.) It is operated by 13 nations, and built under license in most of them. Its small size and non-magnetic steel hull make it exceptionally difficult to locate. Argentina, India, Indonesia, South Korea, Brazil, Chile, Colombia, Venezuela, Peru, Greece, Turkey, Ecuador and Israel all operate Type 209's. The hull displacement varies from 1200 to 1500 tons, depending on the year delivered and the options desired. Source: USNI Database, 1994, Ships, Submarines.

65. I estimate that it measured an area roughly 150nm by 100nm. The greatest concentration of British shipping had to be close to the Falklands to support an amphibious operation. The limited range of Sea Harriers kept Woodward within 100 nm of the Falklands, as did other mission requirements. I base my estimate on a map study of the area and the limitations on Woodward's

fleet. If the British Fleet temporarily withdrew, *San Luis* merely had to wait for them to close again, since Woodward's mission and area of amphibious action was bounded by the Falkland Islands.

66. Woodward, p. 92-92. Woodward's deadline to complete his force projection mission was mid-June, due to weather and fleet readiness. An additional concern later in the campaign would be the declaration of a cease fire prior to all British goals being achieved.

67.Woodward, p.185., was concerned that the UN might declare a cease fire before he reached the post-conflict phase of his operation.

68. The submarine entered Indian Service in 1988, and was returned to the Soviet Union in 1991. Apparently, the Indian Navy was exploring the feasibility of building and operating nuclear submarines. Source: USNI Database, 1994, Ships, Submarines, India. Their recent production and purchase of German and Russian diesel submarines, the Type 209 and Kilo respectively, suggests that they could not afford the industrial infrastructure required to support nuclear submarines, train their crews, and maintain a reasonable margin of safety. Buying more diesel submarines apparently fit their needs more cost effectively.

69. Wixler, Kieth, LT, USN. " Argentina's Geopolitics and Her Revolutionary Diesel Electric Submarines" Naval War College Review Winter 1989 p. 86-107. Also Robert L. Scheina, "Santa Cruz: Record Setter" Proceedings Jun 1985, p. 107-109.

70. Japan has the shipbuilding industrial base to develop nuclear submarines, however the political climate and professed "purely defensive" structure of their Self Defense Forces , The Maritime, Air, and Land , make it unlikely that Japan will build a nuclear attack submarine any time soon. They currently operate three classes of well-built and professionally manned diesel submarines.

71. Keeping the industrial base alive led to extension of the *Seawolf* program to three units, to maintain industrial infrastructure until the smaller, less expensive *Centurion* class completes the design and approval process. Though still officially called NAS(New Attack Submarine), the *Centurion* class has received considerable coverage in Proceedings. The lead ship of the class is currently planned for procurement in 1998. The third and last Seawolf will begin construction in FY 96. Force 2001, pp. 74-76.

72.USNI Database, 1994, Ships, Subs, Germany, Sweden, Russia.

73.Office of Naval Intelligence "The Closed Cycle Diesel Engine/CCD" Translation of Grabowski, Marcia M. "Kreislaufdieselmotor/CCD" Soldat und Technik (Germany) n3 1993, p. 178-179. Washington DC 1993, p. 3.

74. Grabowski, p. 178. There is not necessarily a direct relationship between submarine indiscretion and submerged endurance. Grabowski points out that indiscretions are probably only reduced by 50% with AIP. This still presents a significant loss of exposure time for ASW forces. Thomas H. Hodgson's Modernizing the Soviet Submarine Fleet, Naval Post Graduate School, Monterey CA. 1990, presents a thorough study of four different AIP options. He found that indiscretion decreased 47%-- agreeing with Grabowski. He points out that high speeds still drain an AIP diesel's charge at a substantial rate, so the offensive employment of AIP's, which require greater submerged speed and range, does not accrue the same advantages that a defending AIP does.

75.Jane's Underwater Weapons Systems, 1992-1993, p. 134. See also 1994 USNI Database, Ships, Submarines, Netherlands, *Walrus* Class .The 53cm/21 inch torpedo is fairly standard size throughout the world. The 65cm is generally found only on Russian models, and Russian model derivatives.

76. Norman Polmar, "Countering Torpedoes," Proceedings, Dec 1989, pp. 119-122. The attack on *USS Stark* prompted further development of less expensive systems, resulting in the Coherent Receiver Transmitter (CORT) modification to the Perry class frigates. CORT improves a non-Aegis ship's capacity to detect and engage sea skimming cruise missiles.

77. The Aegis missile system was designed to defeat a multiple ASCM attack from submerged submarines and attack aircraft. Most submarines have six or eight torpedo tubes. (Based on review of USNI 1994 database and Jane's Fighting Ships 1992-93.) The maximum salvo from a submerged submarine does not exceed our capacity to defeat it.

78. The literature is comprehensive. For the Russian perspective, see Jacob W. Kipp, Naval Art and the Prism of Contemporaneity: Soviet Naval Officers and the Lessons of the Falklands Conflict (College Station: Center for Strategic Technology, Texas A&M University, 1983.) Numerous articles in Proceedings, 1982 through 1984, refer to the Falklands/Malvinas War. Dr Robert Scheina's "The Malvinas Campaign" May 1993 and "Where Were Those Argentine Submarines" Mar 1984 are concise views of the Argentine side. See also Train, Harry D.,II, ADM, USN(Ret). "An Analysis of the Falkland Island/Malvinas Campaign" Naval War College Review Winter 1988 p. 33-50.15., Wixler, Kieth, LT, USN. "Argentina's Geopolitics and Her Revolutionary Diesel Electric Submarines" Naval War College Review Winter 1989 p. 86-107., Cragg, Clinton

H. The United States Versus The Third World Submarine: Are We Ready? Naval War College , Newport RI 1991, Lawton, Frank C. The Third World Submarine Threat-- Another Great Equalizer. Naval War College, Newport, RI. 1991., Lokkins, C. J. Falklands War: A Review of the Sea-Based Airpower, Submarine and Anti-Submarine Warfare Operations Air War College, Maxwell AFB, AL. 1989,. Mackin, John J. The Submarine in Low Intensity Conflict: Lessons From the Falklands. Naval War College Newport RI 1990. This is by no means an exhaustive list.

79.Refer to earlier note: Secretary of Defense Report to the President and the Congress, 1994, p. 166. "...the most worrisome [threat] are anti-ship cruise missiles, which are becoming increasingly available around the world through foreign military sales."

80.The Pakistani Navy offers another example. The *Hagor* (French *Daphne*-class)sank an Indian frigate in the 1971 war-- 191 of the 288-man crew went down with the ship. High loss of life is usually the result of either fires out of control or, more likely, very rapid sinking. USNI Data base 1994, Pakistan, ships, submarines. See also CDR Eric Rosenlof, USN "Contingency Blues." Proceedings January 1995 p. 56.

81. NDP-1, p. ii. The sentence actually ends "...operations other than war," however its meaning does not change without those words. In fact, that ending appears to be well out of context for the introduction of naval doctrine written on that page. Given that this is the opening paragraph of the Navy's first doctrinal publication, and OOTW is a subset of naval warfighting, it appears as if it was an editors error. KAR.

82. A useful discussion concerning how naval doctrine fits into today's joint doctrine can be found in Dr. James Tritten's "The Art of the Admiral: Doctrine for the Fleet" AMSP Course 1 Readings, (Fort Leavenworth: USACGSC Press, 1994.) Dr Tritten works for the Navy Doctrine Command.

83. NDP-1 p. ii.

84.NDP-1, p. 51. This position differs somewhat from the Joint Pub 1-02 definition of doctrine: "...principles by which the military forces or elements thereof guide their actions in support of national objectives. It is authoritative but requires judgement in application." Joint Publication 1-02 "Department of Defense Dictionary of Military and Associated Terms" Washington D.C.: U.S Government Printing Office, 1994. This definition is hardly "Joint"--it was derived from land force doctrinal definitions, and became Joint Doctrine by virtue of having been published by the Join Chiefs of Staff. Doctrine by directive better approximates dogma than a shared understanding of how to think about war. Truly

"joint" doctrine requires each service to make doctrinal inputs as entering arguments, and then arrive at common understandings and definitions through consensus. The demand for an official naval doctrine is not new to the post-cold war era. LCDR Dudley Knox championed the need for a comprehensive Naval Doctrine as far back as 1915. See Knox, Dudley W. "The Role of Doctrine in Naval Warfare, " United States Naval Institute Proceedings 41 (March-April 1915): 325-354. Copyright @ 1915 by the U.S. Naval Institute. Excerpt reprinted in US Army Command and General Staff College, C610 Syllabus/Book of Readings, 213-227. Fort Leavenworth: USACGSC. July 1992.

85. Leaving the initiative in the hands of the opposing submarines cost the allies over 2800 ships lost to German submarines in WWII. NDP-1, p. 32. A better idea was certainly in order, hence the hunter killer group.

86. Tom Stefanick, Strategic Antisubmarine Warfare and Naval Strategy, questioned the premise that we could target all Soviet SSBN's, particularly those operating in Soviet home waters with the longest range missiles, with *Sturgeon, Permit, Skipjack,* and *Los Angeles* attack submarines. He concludes it was unlikely. The Soviets put SSN's out on anti-SSN patrol as escorts to their SSBN's. U.S. SSN's developed sub vs sub dogfighting doctrine, and establishing the quieter American submarines as the most capable single antisubmarine platform. (A view also held by Admiral Woodward, see One Hundred Days, p. 123.) The key to their success in this role was their marked acoustic advantage over Russian SSN's (See Stefanick, Appendix 1). The US Navy concedes that it may no longer hold this acoustic advantage over the newer SSN's, and some modern diesel submarines operating on battery power.

87. See Stefanick, Appendix.. 6.

88. The Japanese submarines were similarly constrained Zenji Orita with Joseph D. Harrington I-Boat Captain (Canog Park: Major Books, 1976.) p. 165.

89. Gerken, p. 659.

90. The use of helicopters on surface combatants in the Light Airborne MultiPurpose System (LAMPS) concept, which as yet does not use dipping sonars, can be traced back to the use of seaplanes on cruisers in World War II. The generic idea is to extend the ships sensors as far beyond the horizon as possible. As better radar, sonar, and electronic surveillance measures have been invented, they have found their way onto helicopters. The dipping sonar is an important innovation, since it combines the ability of a variable depth sonar to exploit the best sound propagation path (See Appendix 1) with the speed and range of an aircraft.

91. The submarines still carried torpedoes in their tubes. Assuming 67% of the Soviet fleet could deploy during the 1987, the US Navy faced 3233 torpedoes and 345 ASCM's: a ratio of 9:1 in favor of ASCM's. LCDR D.F. Glick, USN, Is The Battle Group Commander Really Concerned About The Threat of a Submarine Launched Torpedo? Naval War College Newport RI Feb 1987. p. 3.

92. The cruise missiles launched by the Charlie class submarine, "Starbright" and "Siren" had ranges of 35 and 65 nm respectively. The newer missiles on the Oscar class, "Shipwreck" had a range estimated at 200nm. See USNI Database, 1994, Ships, Submarines, Russia; and Jane's Weapon Systems 1988-89(Surrey: Jane's Information Group, 1989) p. 457.

93. AAW and ASUW were also based on sinking the ship or aircraft carrying a missile before it launched its weapon. This resulted in the F-14 Tomcat /Phoenix missile program, adaptation of the Harpoon missile for launch from the P-3, A-6, S-3 and F/A-18 aircraft, and the use of long range radars on S-3s, P-3s, and SH-60s. The Tomahawk Antiship Missile (TASM) was originally designed to allow a ship or task group without a carrier to attack enemy ships far over the horizon.

94. Glick, p. 3 .

95. Technically, a cruise missile firing SSN is referred to as an SSGN. However, with the advent of the torpedo tube launched cruise missile (for example Harpoon, Exocet, and Tomahawk, and the Russian SS-N-21) the distinction between SSN and SSGN has blurred. I use SSN for simplicity's sake.

96.CDR Charles W Mayer, USN, discusses this in his article "Looking Back Into the Future of the Maritime Strategy, Are We Uncovering Our Center of Gravity in the Attempt to Strike at Our Opponent's?" Naval War College Review Winter 1989 p. 33-46. There is some question whether or not the long range diesel submarine threat was fully countered. However, since Russian home waters were not necessarily the desired AO for American battlegroups, and control of the sea routes to reinforce Europe were the minimum required ends, the measures taken to defeat SSN's incorporated neutralizing long range diesel submarines as a threat to Atlantic sea lines of communication.

97. During my career, I have heard numerous senior officers suggest that the *Los Angeles* class SSN purchase was finally endorsed by Congress when the concept of an underwater "circle of steel" around a carrier was proposed as part of the deployment doctrine. Regardless of the amount of truth in that opinion, only a nuclear attack submarine was fast enough to keep up with a modern carrier battle group, and provide a screen or advanced guard while maintaining the stealth

submarine's require to survive. The acoustic advantage enjoyed by American SSN's for over 25 years (see appendix 1) provided the detect/engage asymmetry to make this an attractive option.

98. Norman Polmar, "Countering Torpedoes" Proceedings Dec 1989, p. 120.

99. Nixie is outlined in Jane's Underwater Weapons Systems, 1992-1993, p. 101. Its actual capabilities remain classified. The Prairie/Masker system is simply illustrated in Gerken, p. 481.

100. Jane's Fighting Ships 1992-93. pp. 713-730.

101. Jane's Fighting Ships 1992-93, pp. 710-799.

102. Jane's Underwater Weapons Systems 1992-1993, p. 102. Ships have had torpedo tubes since before World war II, yet the SSTD system had to wait until the 1980's for development. Defense contractors must produce a successful self-defense torpedo to remedy this oversight.

103. Jane's Underwater Weapons Systems 1992-1993, pg. 102. The Royal Navy and the U.S. Navy began this program as a joint venture, however they differ in philosophy. The British want a combined hard kill/soft kill system--i.e. underwater chaff and the torpedo. The U.S. prefers only a hard kill system.

104. Jane's Underwater Weapons Systems, p. 148.

105. See comments from AIRTEVRON ONE message, *supra* note 95. Part of the problem lies in comparing the sonar reflecting cross sections between 53 cm torpedoes and a *Kilo* submarine. A 53cm torpedo, approximately 15' long, has a total surface area of 82.5 sq ft, a maximum cross section of 26.25 sq feet, and a minimum cross section of 5.5 sq ft. A kilo submarine has a maximum cross section of 5060 sq ft and a minimum cross section of 704 sq ft. These dimensions differ by two orders of magnitude. If the Mk-46 is assessed as unreliable against submarines, what are its chances against torpedoes with 1/100 the sonar cross section? Compare this problem with a radar guided missile:

Tracking and targeting the torpedo lags three times as much as a missile shooting down other missiles. Electromagnetic energy travels 196,416 times faster than sound.(6 orders of magnitude:.186000 mps x 5280 f/m = 982,080,000 fps. Sound travels roughly 5000 fps in seawater. Assume a cruise missile target travels Mach 2 (average among many models of cruise missile; some are subsonic, some are hypersonic, some are supersonic); 2x760 mph at sea level,=1500 mph. Torpedo travels 50 mph, 1/30th the speed. The tracking/targeting problem

represented by relative speeds.

Speed of radar / speed of missile =982080000/(1500x3600) =182.

Speed of sound/speed of torp=5000/(50x5280/3600)=68.

This makes the tracking and updates to the computer's fire control solution 1/3 slower. The ships weapons computers operate at roughly the same processor speed on a given ship.

106. Glick, p. 3 .

107. Glick, p. 9.

108. LCDR Scott Kelly, USN, :"Carrier ASW, Can Do" Proceedings June 1990 p. 76.

109. Glick, p. 9; quoted from Hamlin A. Caldwell, Jr., "Using and Fighting Submarines," Proceedings, Aug 1984, p. 66.

110. *Supra* note 6, Secretary of Defense Report, 1994.

111. Flight IIA starts with DDG-68. 17 of the U.S Navy's newest, most modern warships, have no organic ASW attack aircraft. Part of the reason the first two flights of the *Burke* destroyer came without helicopter hangars was keeping cost low to get the ships approved by Congress. Another factor was the assumption that plenty of *Perry* class FFG's would remain in the fleet--all of the *Burke* destroyers were equipped with the SSQ-89 LAMPS avionics suite, permitting total LAMPS sensor capability provided a LAMPS helicopter was available from another ship. With two to three FFG's available for every battle group, this made sense. "A pair of FFG-7's with 4 SH-60B's embarked can keep aircraft aloft virtually indefinitely." CAPT Robert J. Shade "Marriage of Necessity," Proceedings Aug 1990, p.31-35. Both CAPT Shade and CAPT Bruce R. Linder ("The Frigate Still Fits," Proceedings Feb 1993, p. 36-41), present the case for keeping a high low mix in surface combatants.

112. Proceedings July 1993, pp. 93-97.

113. My sources for this position are two officers: one in N8, and on at Naval Air Systems Command. They insisted on non-attribution. Current fiscal constraints make every resource choice a death knell to alternate systems. The climate at the Pentagon could make "complaints" come across as "disloyalty," at a time when unity of position is critical in the face of a congress looking for ways to justify fiscal savings. One must not conclude that the navy is blithely ignoring funding ASW systems-- it is taking risks in that area due to a raw lack of funds and the perceived odds that the most likely threat to an American force will come through the air or from space.

114. ADM William Owens, ASW "Still a Priority" Proceedings, Mar 93, p. 127.

115. ASW permeates all seven Joint Mission Areas assessed as fundamental to effecting future Naval Doctrine and force planning: Joint Strike, Joint Littoral Operations, Joint Surveillance, Space and Electronic Warfare, Strategic Deterrence, Strategic Sealift and Its Protection and Forward Presence. Force 2001: A Program Guide to the U.S. Navy Washington: Deputy Chief of Naval Operations 1994. p. 22.

116. Forward...From the Sea. In strategic imperative section.

117. Proceedings July 1993, p. 93-97.

118.USS *Princeton*, (CG-59), and USS *Tripoli* (LPH-11), were removed from the American order of battle during Operation Desert Storm by mines with warheads between 200 and 300 lbs. The warhead on a torpedo is typically 200-400 lbs, 900 lbs for the 65cm Russian wake home. It only takes one hit to put a crimp in our power projection force's operational rear.

119. ADM William Owens, USN "ASW Still a Priority" Proceedings Mar 93 p. 127.

120. Joint Pub 1, p. 5 .

121. Traveling into geographically constrained launch boxes can disrupt the ASW search effort. This is heavily METT-T dependent.

122.Owens, p. 131.

123. John F. Morton, "The Shallow-Water Diesel: A New Priority," Proceedings Mar 1993. p. 128.

124. Morton p. 128.

125. Morton, p. 129. This is an odd assumption , considering that *San Luis* made her first attacks submerged! Woodward supports Morton's article in conceding that submerged approaches to attack are quite difficult. However, even a crew that "couldn't pass a Perisher" made a submerged attack, only to be foiled by defective equipment. This would suggests that submerged approaches are a demonstrated capability.

126. Morton, p. 129.

127. While Fuller's use of this term held a pejorative connotation, the term ignorant is meant to imply that we, as a service, are ignorant of what will actually happen in the future: in the sense of "lacking knowledge or comprehension of a thing specified" ,i.e., the future. Webster's Ninth New Collegiate Dictionary, (Springfield: Merrian-Webster Inc., 1987) p. 598, def. 1.a. We can only predict with varying degrees of uncertainty. Uncertainty is a state of being, not a condemnation of our current doctrine or force structure.

128. If the hit is merely the perceived threat of being able to deliver an effective blow, one has certainly accrued the advantage of a hit without expending the energy. Movement will never defeat an enemy. It must be coupled to a hit, or the perceived threat of a successful hit.

129. Recall the "invisible" rifleman described by Bloch ad du Picq who changed land warfare forever. Consider the current army focus on the sensor to shooter link for precision weapons. Look at the effectiveness of an ambush. Consider the "invisibility" of effective guerilla forces, who blend in to local populations until prepared to deliver a blow. Stealth aircraft raft are but the latest innovation in the art of invisibility, what the Japanese call Ninjutsu. The foundation of any deception plan is preventing enemy detection the decisive blow.

130. Sun Tzu's assertion that "War is based on deception" implies that Fuller should have included "detect" in his maxim. Fuller's fascination with triad's, and his entire purpose behind the maxim was to keep it simple--after all, he was providing a maxim for "the ignorant."

131. Alan R. Washburn Search and Detection, (Arlington: Operations Research Society of America, 1981), p. 2-5. The reason ship radar search is not discussed here is that the area coverage provided by an aircraft flying 100 knots (helicopter) or 300 knots(S-3), at altitudes of thousands of feet where radar detection range is limited by equipment and not sensor horizon, far exceed the search area of the ships line of sight limited radar. Of course, the ships radar will generally provide some coverage within the torpedo danger zone, these detections may or may not be recognizable from sea clutter. This is due to the shallow grazing angle of the ships radar relative to the surface of the water.

132. Operations Analysis Study Group, United States Naval Academy Naval Operations Analysis, 2d edition, (Annapolis: Naval Institute Press, 1977), pp. 62-64 Most ASW missions in SH-60 and S-3 aircraft are 3 to 4 hours long. P-3 missions can last up to 12 hours. Ship board watches are generally 4 hours long. For 200 out of the 240 minutes an operator is at his console, he is, at best 75% effective. 0.75 x 0.97 = 0.73, or 73%.

133. CAPT Benjamin P. Riley, III, USN, Training for a New Weapon System: Proposals for Introducing a New Maritime Patrol Aircraft Weapon System to the Operational Active and Reserve Forces. Naval War College May 1991. p. 4.

134. The French PIVAIR search periscopes and British F 5000 periscope suite are two examples of currently available technology with these advanced features. Jane's Underwater Weapon Systems 1992-93, p. 129 & 135.

135. Sonars in service in the 1980's could detect mid sized surface combatants 60 to 80 miles away. Robert L. Scheina, "Santa Cruz: Record Breaker" Proceedings Jun 1985, p. 108. The detection asymmetry is exacerbated in power projection roles by the following factor: the submarine is looking into deeper water, which will have less ambient noise that inshore waters. The ASW forces are looking into noisier shallow water. Compounding this is the greater acoustic signature of the expeditionary shipping. See Appendix 1, p. 2., under passive sonar equation. The importance of NL, SL, and DI are key.

136. Owens, p. 131.

137. Robert R. Mackie, and C. Dennis Wylie Attack Decision Making in Surface Ship ASW: Historical, Theoretical and Experimental Data Human Factors Research Inc, Goleta CA. 1973.

138. *Spartan* and *Splendid*, the "other" two British SSN's in the AO, never received permission to attack.

139. The decision to use conventional torpedoes, with wire guided torpedoes as a backup, flies in the face of the high-tech, precision weapons myopia in the US Navy. The logic was sound-- the Mk 8's larger warhead would be more effective in penetrating the hull of *Belgrano*, a WW II vintage cruiser designed with torpedo protection below the water line. The cruiser's steady course and speed presented a simple firing solution to the sub commander. His problem was to remain undetected while closing with the cruiser, to ensure that *Belgrano* would have insufficient time to avoid the "dumb" torpedoes by maneuver.(1400 yards is quite close-- KAR) The *Belgrano's* sonar operators never heard the torpedoes--the captain's first indication of torpedo attack was weapons impact. Woodward, Middlebrook, and Hastings tell the same story.

140. Middlebrook, Fight for the Malvinas p. 80., quoting Commander Fernando Azcueta, captain of the *San Luis*: "The crew was not fully trained because it was early in the year; we had taken a completely new crew aboard in January... they did the best they could." One explanation for the wire guided torpedoes'

failure was the submarine's faulty fire control computer. Another explanaiton, offered by the torpedoes' German manufacturer, Telfunken, was the crew's failure to properly align the torpedoes with the fire control computer. Post war training by German technicians appears to substantiate this claim, since numerous successful torpedo runs were executed when following procedures under contractor guidance.ADM Harry D. Train, USN(Ret) , The Falkalnds Islands Campaign, Understanding the Issues: A Case Study NWC 1115 [Unclas version] Naval War College, Newport Rhode Island. Jan 01 1986, p.44. In any case, the torpedoes went searching for targets other than the ones Commander Azcueta was aimed at. Since none of the torpedoes was recovered, exact causes for their failures may never be known.

141.failure Commander Azcueta never specifically mentioned the need to evade an acoustic homing torpedo in his discussions with Middlebrook in The Fight for the Malvinas. Scheina's articles in Proceedings have nothing further to add. This leads one to conclude that if any torpedoes were dropped near the *San Luis*, they either malfunctioned, or were never close enough to acquire her. Had Azcueta evaded a homing torpedo, he would doubtless have been quite proud of that fact and it would probably have emerged during Middlebrook's interview with him. The torpedo evasion problem facing submarine commanders is like the fighter pilot's evasion against missiles. He deploys decoys and uses maneuver to break the lock the seeker head has on your craft. In shallow water, there is less depth for the sub to work with, so his evasion problem approaches a two dimensional solution relative to deep water evasion.

142. Naval message, AIRTEVRON ONE 011201Z NOV 94 (UNCLAS) Addressed to CNO and all ASW activities. Subject: Summary of Littoral Air ASW conference held VX-1, Patuxent River, Md 11-14 October, 1994. Para 3. The Mk-48, submarine-launched torpedo, which is currently receiving the ADCAP improvement, is, like most submarine launched torpedoes, effective against anything floating, and assessed as highly effective against submerged targets. See Jane's Fighting Ships.1992-1993, p. 134. Procurement of the Mk-50 torpedo, originally meant to replace the MK-46, has been drastically cut back. It will not replace the Mk-46 as the primary ASW weapon any time soon.

143. LCDR Kevin P. Peppe, USN, "Submarines in the Littorals," Proceedings Jul 1993, p. 48.

144. Force 2001,p. 15.

145. Hon. Ike Skelton, "This is no Time for America to Downsize its Military." Kansas City Star, 26 June 1994, 14 (I). Skelton cites the attack on Pearl Harbor, the invasion of South Korea, the Cuban Missile Crisis, the attacks on *Liberty* and *Pueblo*, the Iranian Revolution, and the Iraqi attack into Kuwait as

examples of our strategic myopia. Assumption presented *supra* 118.

146. Force 2001, pp. 85-92. Sensors which can solve the sonar detection problem in shallow water are bistatic sonars, which allow one sonar to transmit while another receives the echo; ALFS, a low frequency helicopter sonar which will detect submarines in shallow water at three to six times current range; LIDAR, a blue green laser, currently used for mine hunting, which can detect submerged objects without resort to acoustics; and RDS, a fiber optics based sonar array optimized for shallow water detection. A new (classified) submarine tactical data system and submarine integrated antenna system(SIAS) should remove the seam between submarines and surface forces in integrated ASW operations. Positive control measures will still be required to prevent"Sighted Sub, Sank Same" reports from being the first evidence of a "blue-on-blue" ASW engagement.

147.Woodward observes that neutral shipping are a valuable source of long range detection data for naval forces. Woodward, p. 126. The global proliferation of information and satellite information shared by neutrals must be considered an asset defending submarines will use to choose patrol areas. Neutral shipping in littoral waters, and other less obvious sources, will give the submarine the cuing it needs to refine its search sector.

148. Ralph E. Chatham, "Fighting Submarines: Confuse the Bastard," Proceedings Sep 1990, p. 54-59.

149. Chatham, p. 58.

150. Force 2001, p. 15.

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Appendix I

ASW Primer

Acoustics

Sound is the primary means for detecting submerged submarines.[1] Unlike air, the medium which conducts light, radio, or IR energy, water absorbs light and electromagnetic energy so rapidly it virtually precludes tactically utility.[2] Passive and active sonar are the primary tools for detecting and classifying underwater contacts:. Passive sonar uses **hydrophones** to listen for submarines. A hydrophone can be a ship or submarine 's hull mounted sonar or towed array, a variable depth sonar, sonobuoys launched by aircraft, or helicopter dipping sonars. Time integration and electronic filters allow sonar operators discriminate between ambient noise and submarines. Range estimates require triangulation. Active sonar transmits a burst of sound into the water, then measures return echoes. The time lapse between sound transmission and echo reception determines range.

The Figure of Merit(**FOM**) for a sonar on a given day is derived by setting the signal to noise ratio(**SN**) equal to 1, and converting it to decibels:

$$10\log_{10}\mathbf{SN} = 10\log_{10}1 = 0.$$

It is assumed that where signal strength equals noise, there is a 50% probability of detection.[3] The passive and active sonar equations predict sonar performance by comparing the local environmental conditions against equipment capability, producing a baseline sonar detection range founded on **SN**.

The Sonar Equations and Associated Terms

Passive sonar equation: SN= SL-NL-TL+DI+RD

Active sonar equation: SN=SL-NL-2TL+TS+DI+RD

FOM(Passive)= **0 = SL-NL-TL+DI+RD**

FOM(Active) = **0 = SL-NL-2TL+TS+DI+RD**

SN= Signal to noise ratio.
SL(Passive)= Source level; the noise a sub makes.
SL(Active)= Sonar power output.
NL= Sound level in surrounding water
TL= Transmission loss; the attenuation of sonic energy in water. Proportional to range.
TS(Active only)= Target Strength. This represents the quality of target echoes. Generally, a larger submarine has more surface area, and a larger TS.
DI= Directivity index; how well sound holds its bearing from the source.
RD= Recognition differential; a quantity combining operator experience and sonar sensitivity. It can have positive or negative value.

TL changes as depth, temperature, time and location change. **NL** is effected by own ships noise, noise made by other shipping, and environmental phenomena. **TL** causes every signal, at some range, to attenuate below a hydrophone's detection threshold. **SL** and **TL** tend to dominate the sonar equation. **DI** and **RD** make the difference between detection and non-detection at the limits of a sonar's detection range. Detection range is influenced by measured sound levels and predicted transmission loss. Once detection occurs, sonar contacts are classified as either submarines or other underwater phenomenon-- merchant vessels, whales, subsurface mountain tops, torpedoes, or friendly ships-- using all available data. The art of classifying sonar contacts is highly subjective.

The world's oceans are not homogenous. **TL** is a function of local water density, temperature, salinity, depth, and pressure. Compared to radar detection, **TL** varies sensor range by orders of magnitude. While atmospheric conditions can

degrade radar detection by percentages, up to 50% in extreme conditions, acoustic conditions can vary detection range by multiples of ten. For example in one region of water, a submarine may be detectable 25 miles away, while in slightly different area, it is detectable only 2 to 3 miles away from an identical hydrophone. Table 1 illustrates the variability of passive sonar detection ranges.

Representative Passive Acoustic Signatures[4]

SL in dB		Detection Range	
		Deep Water	Shallow Water
190			
	Merchant ship Aircraft Carrier[5]		
180			
	Amphibious Ship		
170	Nautilus SSN		
	Victor I SSN		
160		20-500 nm	10-70 nm
150	George Washington SSBN		
140	Victor III SSN		
130	Sierra SSN	1-25 nm	1-15 nm
	Diesel submarine on battery (early 1980's)		
120	Akula SSN NATO SSN's		
	Modern diesels w/improved sound isolation[6]		
110	Los Angeles SSN (est)		
		0.2- 4.0 nm	0.1- 4.0 nm
100			
	Seawolf SSN(est)		
90	Ohio SSBN(est)		

Notes: 1. Range of error~ 25 dB. dB is referenced to 1 Micro Pascal at 1 Yard. Below 90dB, detection range approaches the length of the submarine, i.e. 200-500 feet.
2. dB is a logarithmic quantity. Doubling the intensity of sound results in a 3dB increase.

Table 1

Active sonar is more heavily influenced by absorption and dispersion than passive sonar. Active ranges vary from a few thousand yards up to 30 or 40 nautical miles, depending on the acoustic conditions and the sonar transmitter's power.[7] The relative bearing from the target to the sonar, called target aspect, alters sensor

detection range through its effects on **TS.**(See Figure 1). As a submarine turns away from an active sonar, detection range immediately decreases due to aspect related reduction in **TS**. When combined with the decrease in signal gain brought on by an evading sub's growing distance from the hydrophone, this dynamic demands the continual repositioning of active hydrophones to maintain sonar contact.

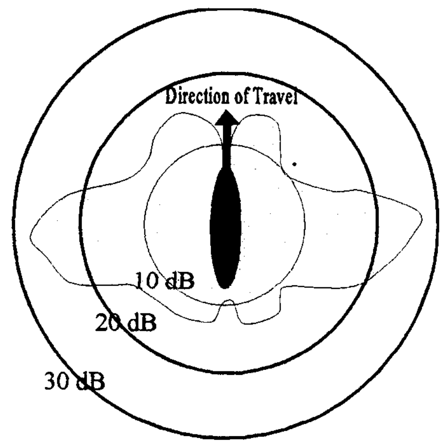

Figure 1: Effect of Aspect on TS

Sound propagation in water occurs in four useable acoustic paths: direct path, ducting, bottom bounce, and convergence zone. (See Figure 2) These paths are determined by the speed of sound in water, which is governed by local water depth, salinity, temperature, and density. Any or all paths may be present in a particular body of water. Direct path is always present to some extent. Shallow water has neither deep sound channels nor convergence zones. Bottom bounce is highly dependent on the type of mud, sand, and/or rock on the bottom of a given area. Ducts depend on water surface temperature, which may vary with time of day. This acoustic path can come and go during an ASW mission.

The tactical impact of sound's unpredictable behavior in shallow water is the constraints it imposes on search plans.

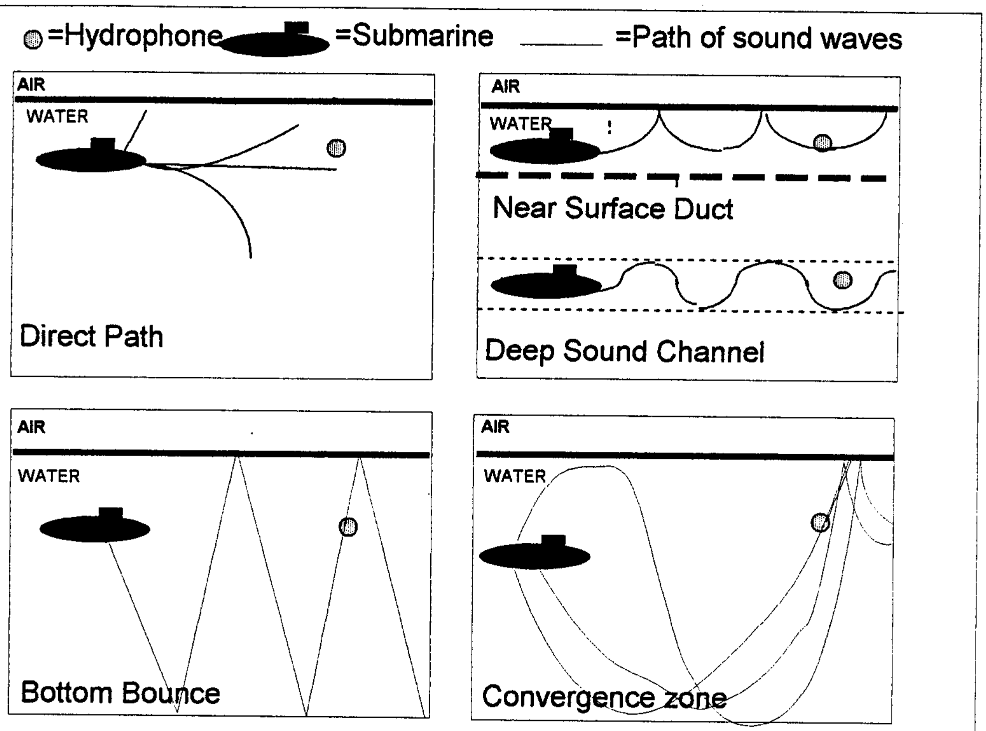

Figure 2: Sound Paths in Water

The results are either over searching, which decreases area coverage for a given search mission, or sub optimized searches containing coverage gaps. The submarine, immersed in the environment, is better able to detect changes in the water conditions, and thereby adjust its depth and speed to exploit holes in an acoustic search pattern. In Figure 3, the dashed region

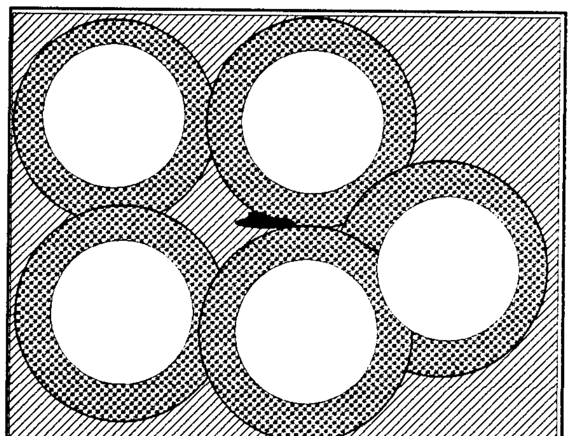

Figure 3: Search Coverage Gaps Due To Detection Range Changes.

represents the area where no contact was expected, the checked region is where

contact was expected but is unavailable due to changing acoustic conditions, and the white region is where contact can actually be gained. Lack of detection could easily be interpreted as evidence that no submarine is present, inducing ASW forces to search elsewhere.

Submerged submarine detection in shallow water is generally constrained to active sonar. Active sonar alerts the sub to the presence of ASW forces. It will generally try to evade active sonar to prevent detection. A sub can mask its presence in shallow water by settling on the bottom-- a technique unusable in deep water. Shallow water is defined as water depths of 600 feet or less.[8] Modern submarines can withstand greater depths .

Magnetic Anomaly Detection and Radar

Magnetic Anomaly Detection(MAD) uses variations in the earth's magnetic field to sense the presence of large concentrations of ferrous of metal-- submerged submarines. Short slant range, around 2500 feet, makes MAD a useful attack sensor but limits its effectiveness as a search sensor.[9] A submarine's best evasion against MAD is speed and movement.(See Figure 4).

Radar and Visual Detection

The submarine's best defense against radar and visual detection is the small cross section of its snorkel and periscope, and operational discipline aimed at minimizing indiscretion. Submarines present small visual signatures, particularly when exposing only a periscope.[10] Most submarines have passive EW sensors which alert them to the presence of ASW ships and aircraft.

This allows the sub to resubmerge, ending its indiscretion. If enough aircraft are available to maintain a continuous radar flood, the submarine must either mask its

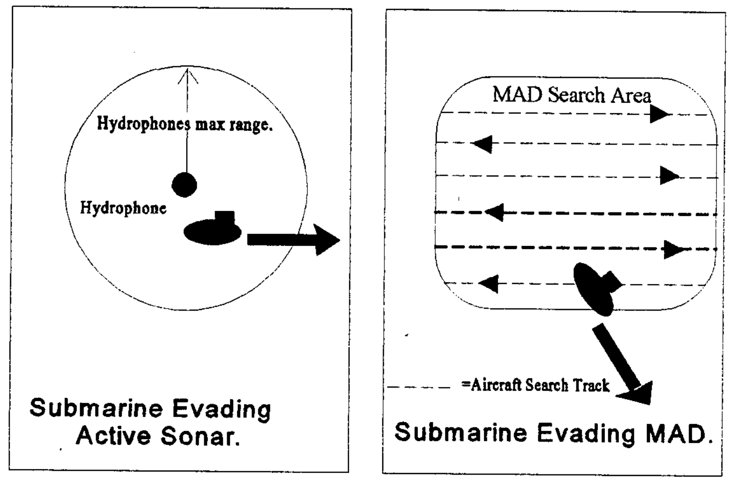

Figure 4: Evasion, a Continuous Process

radar signature by operating near a friendly vessel, or evade while submerged. An AIP modified diesel can charge its batteries while its is evading. Conventional diesels can be forced to surface by constant pressure requiring sustained submerged evasion, there by draining battery charge. This requires multiple ships and aircraft working together around the clock. Radar creates difficulty for a submarine, but cannot guarantee that a proficient commander will not achieve penetration into the torpedo danger zone.

Summary

Submarines are selectively vulnerable to a variety of acoustic and non-

acoustic sensors. Initial detection remains the primary ASW challenge. Once initial contact is gained, combined armed and active sonar can often maintain contact until the submarine is localized with sufficient precision to employ a weapon. However, the submarine usually achieves first detection, and maintains the initiative by actively evading ASW forces.

Detection Asymmetry

Sensor	ASWFOR	Submarine	Advantage
Sonar(P): Good day Bad Day[11]	2-8 kyds 0.1-2 kyds	20-150+ kyds 2-30 kyds	Submarine. Prairie and Masker reduces subs edge.
Sonar(A): Good day Ship Aircraft Bad Day Ship Aircraft	 10-20 kyd 5-10 kyd 5-10 kyd 2-4 kyd[12]	Won't use if escorts are nearby.	Submarine: Counter detects twice the range. ASWFOR: Many sensors at once.
Radar Aircraft (Ship limited by clutter and mast height.)	Assume searching for periscope or snorkel.[13] Surfaced sub easily detected 40-60 kyds away.	Won't use if sub hears escorts or detects aircraft radar.	Submarine: Counter detects at twice radar range.
FLIR/ Visual[14]	1-5,000 yds; depends on visibility.	10-30 kyds; Visibility & ship size dependent.	Submarine.

Attack

Submerged submarines are less vulnerable to torpedoes than ships are, due to the difficulty in creating a firing solution. Using helicopters or fixed wing aircraft as ASW attack platforms allows the host ship to stay out of torpedo range while attacking the submarine. For ships without helicopters, the rocket thrown torpedo, such as the Australian Ikara or American ASROC, provides another

method to achieve favorable range asymmetry.[15] However, every attack depends on finding the submarine. (See detect above.)

Attack Asymmetry

Torpedo	Range	Speed	Target Speed	Impact time[1]	Max hit range
Conventional	10kyds	45kts	25kts	6 min	5-7kyd
Acoustic	20kyds	45kts	25kts	10min	9-12kyd
Wire guided	40kyds	55kts	25kts	20min	22-25kyd
Wake Homer	54kyds	55kts	25kts	30min	30-35kyd
ASROC/IKARA	10-20 kyds	45 kts(torp)	20 kts	<5 min	10-20 kyd
Air launched	11kyds	45kts	20kts	16 min	<7 kyd[2]

Notes: 1. Table assumes full speed flight as soon as the torpedo is fired. Since changes in course and speed are usually required , and it takes a few minutes to accelerate to full speed and turn away from a torpedo, the impact time is extremely optimistic. Max hit range variation allows for this.
2. The effective range is a fraction of this figure; the torpedo's sonar transceiver has far less power than a ship's, while it is effected by the same environmental factors.

Torpedo Summary[16]

Type	Range(yds)	Speed (kts)	Counter
Conventional	up to 20,000	40-55	Maneuver
Acoustic Homing	10,000- 20,000	40-55	Decoy/Maneuver
Wire Guided	10,000-40,000	40-55	Decoy/Maneuver
Wake Homing	20,000 - 54,000	40-55	None yet.

Endnotes to Appendix A

1.An easily understood discussion of detection theory is contained in Naval Operations Analysis, (Second Edition, Operations Analysis Study Group, United States Naval Academy) Annapolis: Naval Institute Press, 1977, Ch 4-10. Stefanick and Gerken also explain the search and detection problems as it specifically relates to nuclear submarines and , to a lesser extent, diesel submarines. A brief, useful text on search and detection theory is Alan R. Washburn, Search and Detection Alexandria: Operations Research Society of America, Ketron Inc., 1981.

2. Gerken, p. 173. On a clear day in shallow water, a submerged submarine can be detected visually up to 200 feet below the surface. However, the observer must be nearly perpendicular to the submarine in order to overcome light refraction at the air-to-water interface, and the high light absorption of water.

3.See Stefanick for derivation, pp. 241-242 , or Gerken pp. 705-706 . See also Washburn, p. 3-1.

4. Summary of Table in Stefanick, p. 278, Appendix 6.

5.Author's estimate.

6. USNI database indicates that the Dutch *Walrus* and Russian *Beluga* appear to have wider diameters than power plants absolutely require, probably to allow installation of sound isolation mounting for their propulsion systems. Tango and Foxtrot submarines are big enough to be retrofitted with AIP so mounted. USNI Database, Submarines, Sweden, Netherlands, Russia.

7.Ralph E. Chatham, "Fighting Submarines, Confuse the Bastards!," Proceedings, Sep 1990, 54-59.

8. Morton, p. 127.

9. Jane's Underwater Weapon Systems 1992-93, p. 137. Improvements in digitization are expected to roughly double this range. The American ASQ-81 MAD is undergoing upgrades to increase its shallow water range 25 to 50%. Jane's, p. 139.

10. In shallow water they are detectable, when submerged, up to 200 feet below the surface--this is highly dependent on water conditions, angle of view, bottom contrast, and quality of daylight. Gerken, p. 173. See also William E. Howard, III, and Owen K. Garriott, "Can You See ships From Space" Proceedings Dec 89, p. 89-94. Space based cameras can conceivably detect wakes and periscopes, using lenses of up to 49x magnification, (p. 93) however the question of how quickly this highly perishable information gets to a ship or plane has yet to

be answered.

11. Stefanick. Appendix 6. pp. 270-278. It took a little extrapolation to derive these numbers, since he admits to having up to a 25 dB error.

12. These ranges are optimistic for shallow water. They were derived from looking at the claims made in print regarding maximum range, which one can assume is convergence zone (See Appendix 1.), and the "max" range settings reported in Jane's Underwater Weapon systems 1992-93, pp. 57-93. One could possibly detect at the max range one had designed the system for, however, daily variance will degrade signal gain, as will anechoic coatings on some submarines. Rubber coatings can be applied to submarines which reduce active detection range 12-50%. LT Wade H. Schmidt, USN, "Top Torpedoes," Proceedings Mar 1992 p. 131.

13. The S-3B ISAR radar is supposed to be quite good at detecting periscopes. Upgrades to it are being pursued to make it able to detect a periscope at 100 nm with over 90 % confidence. See Proceedings Sep 1993, p.90. That capability cannot be expected to be in the fleet before 2001, if ever.

14. Visual detection asymmetry example: A Ticonderoga class cruiser has a very identifiable superstructure. Its flight deck in 35 feet above the water line. Its identifiable features start about 35-45 feet above the water, extending up to 75-85 feet. A periscope will protrude from 3 to 5 feet out of the water. The visual line of sight = $\sqrt{(2x5)} + \sqrt{(2x45)} = 3.1+9.3 = 12.4$ miles. Visual detection of a periscope is not likely at 12 miles. In fact, it is unusual as close in as 3000 yards. See CAPT William J. Ruhe, USN(Ret), "Blowing the Japs out of Shallow Water," Proceedings Dec 1989, p. 63: "The Jap sailors never saw us in broad daylight, less than 3000 yards away...we shot at 1,200 yards, and were still not sighted."

15. Jane's Underwater Weapons Systems 1992-1993, p. 130. These weapons employ a rocket booster to launch a homing torpedo up to 20,000 yards from the ship.

16. Jane's Underwater Weapon's Systems 1992-93, pp. 149-151, 154 and Norman Polmar, "Countering Torpedoes," Proceedings Dec 1989, p. 120.